PROJECT STUDY ON A WET PROCESS CEMENT PLANT OF 4,500 BARRELS PER DAY CAPACITY

Prepared By:

INDUSTRIAL ENTREPRENEUR CO., INC.
MANILA, PHILIPPINES

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FOREWORD

In answer to the present crying need for more cement in the markets of the Philippines, the INDUSTRIAL ENTREPRENEUR CO., INC. organized a team of seasoned cement technologists experienced along the different professional lines involved in the cement industry to make a preliminary survey of possible good sites for cement plants all over the Philippines and to make a project study for the site chosen by the team as the first priority after considering the sites from all possible technical and economic angles. Although the site recommended in this project study is considered highly desirable, there are still many others which may be considered almost as good as the one recommended. The Philippines being generally composed of coralline islands, the choice of plant site is largely just a matter of priority. No one site can claim to be the only desirable site to the exclusion of others which may be closely just as good. Under this spirit, therefore, this survey team is recommending the particular site mentioned in this project study.

The following sources of information contained in this project study are hereby acknowledged:

1. All the existing cement plants in the Philippines, for their kindness in furnishing us their respective historical backgrounds especially regarding their respective growths in productive capacities. This collective information gave us material for Table No. I in Part II (Market Study)

2. The National Economic Council of the Philippines, for information on the actual production of the different plants in 1962, as contained in Table No. II of Part II.

3. The Bureau of Census and Statistics of the Philippines, for the production and importation figures from 1951 to 1962 inclusive, as contained in Table No. III of Part II.

4. The various American, European and Japanese cement equipment manufacturers, for ideas on the designs and specifications of the equipment involved in the project plant, as contained in Part IV.

5. Fried Krupp of Germany, and F. L. Smidth of Denmark, for their respective studies between the dry and wet processes, as discussed in Section (d) of Part V.

The survey team, under whose supervision this project study has been prepared, is composed of the following persons:

1. Mr. Ricardo H. Veloso	Project Director
2. Mr. Jovencio S. Cabreros	Project Chief Chemist
3. Mr. Eufemio B. Diaz	Project Chief Engineer
4. Mr. Leonardo V. Javier	Project Geologist and Mining Engineer
5. Mr. Candido Litorja	Project Mechanical Engineer
6. Mr. Isidro B. Asok	Project Electrical Engineer
7. Mr. Jose Ramos	Project Civil Engineer

Each of the first five members of the Project Survey Team has an experience of, at least, twelve years in the cement industry; each has held the highest position in his professional line in the plant management level; and the Project Director has twice held top positions in the central management level of two cement corporations.

INDUSTRIAL ENTREPRENEUR CO., INC.

By: RICARDO H. VELOSO
President and General Manager

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May 7, 1963

PART I.

INTRODUCTION

It is a matter of common knowledge that the Philippine economy is presently facing very serious problems, foremost among which are unemployment and high prices. The present administration is trying to solve these multifarious problems by means of the so-called socio-economic program. Without going deeper into an intricate analysis of the aspects of the nation's economic program we may first deal with the way the nations have grown economically and industrially. We very well know that the pioneer nations expanded industrially from the basic raw materials to the most complicated present day products of industry. In other words the industrial growth has been from the bottom up in the ladder from the simplest to the most complicated products produced from natural resources. The industrial growth of the country that has come very much later in the industrial scene, however, can not follow the growth pattern of the pioneers for the simple reason that before basic processes can be commercially operable the market of its products must first be assured in the form of established finishing plants which produce the ultimate consumer products. It has become necessary, therefore, that a country which is industrially a late comer, so to speak, must grow backward from the finished products to the basic raw materials. In other words the finishing plants must first be in operation with imported raw materials before the basic plants which produce such raw materials from the natural resources of the earth can be established. This is the general picture of the various industries established in the Philippines, such as the steel, textile, flour, the chemical industries, etc.

There are, however, some exceptions to this general rule, foremost among which are the plywood and the cement industries which can be easily installed as integrated basic industries with all the processes from the natural raw materials to the various cement products known in modern industry. It is also a very well known fact that the three basic industries consisting of timber, cement and steel practically comprise the fulfillment of the third of man's three basic needs of food, clothing and shelter since the three industries form the basic construction materials for man's shelter. It is, therefore, with the foregoing ideas that the promoters of this project have gone into the serious consideration and presentation of this project study.

The cement industry in the Philippines started in 1914 when a society of Spanish Catholic Priests, employing Krupp German technicians, put up a five-hundred-barrel-per-day cement plant in Binangonan, Rizal. The religious society owning the plant gave its management to the Ynchausti & Company in 1916. The same firm subsequently purchased the plant in 1924 thru auction. After a non-too successful operation of about twelve years, the Ynchausti firm sold out to Madrigal & Company in 1928. This was the beginning of the Rizal Cement Company. In the meanwhile the Philippine government through the National Development Company, after a thorough technical study which started in 1918, established the Cebu Portland Cement Company with its 1500-barrel-per-day plant located in Naga, Cebu, which was put in operation in 1922. Both plants duplicated their capacity before the beginning of the second world war in 1939. Almost immediately after the liberation of the Philippines the Lopez brothers of Iloilo, Fernando and Eugenio, began negotiations for the acquisition of a pilot cement plant in the United States with a productive capacity of only 600 barrels per day. This plant was subsequently installed in the island of Guimaras, across the narrow strait from Iloilo city, in 1947. In 1948 the Cebu Portland Cement Company added two more units to its already duplicated plant, thus quadruplicating its original capacity of 1500 barrels per day. In 1950 the ground work for the establishment of the second plant of the Cebu Portland Cement Company located in Bacnotan, La Union, was laid out. The original capacity of this new plant was 2,000 barrels per day and its product was introduced into the market in 1952. This plant was subsequently sold to a private firm, the Bacnotan Cement Industries, Inc., in 1957. In 1958 the new owners of the plant expanded its capacity by an additional 1,600 barrels per day or 80% of the original production. In 1955 the ground work for the first dry process cement plant in the Philippines was laid out in Norzagaray, Bulacan, under the Republic Cement Corporation. This plant was completed in the middle of 1957 with a capacity of 2,500 barrels or 10,000 bags per day. This plant became the first attempt by Filipino Cement technologists to produce cement under the so-called Fuller-Humboldt dry process with the suspension type pre-heater.. The production of this plant was duplicated early in 1960 by the addition of another similar unit to the original one. In 1958, under the new Reparations agreement between the Philippines and Japan, the acquisition of another 2,500-barrel-per-day cement plant was negotiated by Durano & Co., for the Universal Cement Corporation. This plant, employing another type of dry process called the ACL process which is a development of the LEPOL process of Germany, was put into commercial operation in the middle of 1960. In 1959 a loan agreement was successfully negotiated between the Development Loan Fund of the United States government and the Mindanao Portland Cement Corporation. The groundwork was started late in 1960 and the plant was supposed to be completed at the end of 1961. Due to some technological errors on the part of the designing engineers compounded by gross mismanagement, however, this plant appears to be doomed to be inoperable before it can even go into a trial operation. This situation is principally brought about by the fact that the foundations and footings were so under-designed that they have considerably settled even before the trial operation. Perhaps the only way left to operate this plant is to dismantle it from the present site and erect it again in some other more stable site on better-designed foundations. This means that this particular plant cannot be put in commercial operation earlier than 1965.

Aside from all the plants mentioned above which are already in operation, except that of the Mindanao Portland Cement Corporation. there are still two cement plant projects of about 2,500 barrels each which are owned by the Filipinas Cement Corporation and San Jose Cement Corporation. These plants are expected to be in commercial operation within 1965.

This project study proposes the acquisition and installation of a wet process plant with a daily capacity of 18,000 bags of cement of 94 lbs. each, which is equivalent to 4,500 barrels or between 750 and 800 metric tons. This plant should annually contribute approximately 5,400,000 bags into the starved cement market of the Philippines. The proposed site of the plant will be in the town of Lugait, Misamis Oriental, in a locality which is described in detail in Part III of this project study. The preliminary engineering aspects and specifications of this plant are discussed in detail in Part IV while the financial requirements are covered by Part V. Although the output of this plant is much too small compared to the present cement shortage in the Philippines it is hoped that at least it will relieve the cement scarcity somewhat.

PART II

MARKET STUDY:

The historical background related in the preceding Part I may be summarized to give the gradual growth of the Philippine Cement Industry as follows:

TABLE NO. I

Plant	Year in operation	Rated daily in Bbls. of 376 lbs.	capacity in bags of 94 lbs.
Rizal Cement Co.	1914	500	2,000
Cebu Portland Cement Company	1922	1,500	6,000
Rizal Cement Co.	1936	1,200	4,800
Cebu Portland Cement Co.	1939	1,500	6,000
Philippine Portland Cement Co.	1947	600	2,400
Cebu Portland Cement Co.	1948	3,000	12,000
Bacnotan (CEPOC)	1952	2,000	8,000
Rizal Cement Co.	1953	1,500	6,000
Republic Cement Corp.	1957	2,500	10,000
Rizal Cement Co.	1957	1,700	6,800
Republic Cement Corp.	1959	2,500	10,000
Bacnotan Cement Industries, Inc.	1960	1,600	6,400
Universal Cement Corp.	1960	2,500	10,000
Rizal Cement Company	1962	3,000	12,000
	Total	25,600	102,400

Although the above table shows a total rated productive capacity of 102,400 bags per day or an annual production of 30,720,000 bags based on the usual 300 production days per year, the following table shows that the actual production in 1962 has been only 22,482,286 bags, which shows an average plant efficiency of only approximately 72.5%.

TABLE NO. II

Name	Rated annual cap. in 94 lb. bags	Production in 1962 in 94 lb. bags
Rizal Cement Co.	9,480,000	6,087,260
Cebu Portland Cement Co.	7,200,000	2,246,500
Philippine Portland Cement Co.	720,000	666,570
Bacnotan Cement Industries, Inc.	4,320,000	4,060,075
Republic Cement Corporation	6,000,000	6,391,520
Universal Cement Company	3,000,000	3,030,361
Total	30,720,000	22,482,286

Aside from the above mentioned producing plants, the construction of two additional plants with a capacity of 10,000 bags per day each is presently pending. These plants are owned by the San Jose Cement Corporation and the Filipinas Cement Corporation with the plant sites located in San Jose, Mindoro; and Teresa, Rizal respectively. Both plants are scheduled by their respective owners to be in commercial operation within the year 1965. Assuming, therefore, that both plants, being new, will produce their full rated capacity of 3,000,000 bags per year each, and assuming also that the plant of the Mindanao Portland Cement Corporation will be put in better hands and on a better site so as to be in commercial production also in the same year 1965, we may, therefore, expect an additional national production of 9,600,000 bags, which added to the 1962 actual production of 22,482,286 will give us a total of about 32,000,000 bags in 1965.

It may now be shown that this production figure for 1965 will still be far too short of the expected cement demand in the market for the same year. It may be remembered that the National Economic Council back in 1958 set the figure of 30,000,000 bags as the estimated demand for cement in the Philippine market of 1962. This figure was arrived at on the basis of the cement consumption in 1955, which was 10,415,800 bags. The unfilled orders for cement during that year amounted to approximately 30% of that total consumption. The combined total of the consumption and the unfilled orders (130% of the total consumption) was then assumed to be only 85% of the total requirements, 15% having been restrained from making orders due to the abnormally high prices and the difficulty in finding the commodity. It may be readily seen that this 15% of the total requirement is equivalent to 23% of the consumption. This means, therefore, that the total requirement for that year (1955) should have been 153% of the total actual consumption as shown in detail below:

Total consumption in 1955	100%
Unfilled orders	30%
Apparent demand	130%
Restrained by price and scarcity (estimated) (15% of total requirement)	23%
Estimated total requirement in 1955	153%

Applying this table to the actual consumption of 10,415,800 bags for 1955, a total estimated requirement of 15,936,174 bags for that year was obtained. Starting with this estimated requirement for the year 1955, a yearly increment of 10% was then assumed for every year, thereafter, resulting in the following table:

1955	15,936,174	bags
1956	17,529,791	"
1957	19,282,770	"
1958	21,211,047	"
1959	23,332,152	"
1960	25,665,367	"
1961	28,231,904	"
1962	31,055,094	"

As a matter of official policy, the National Economic Council simply rounded off the figure for 1962 into 30,000,000 bags.

Very recently an international economic authority estimated the present cement shortage in the Philippines to be about 10,000,000 bags which if added to the 1962 actual production figure of 22,482,286 bags will closely support the estimate of the National Economic Council. We may therefore, feel justified in continuing the above table for the purpose of getting a projection into the requirements of the Philippine cement market for the whole decade up to 1970, thus giving us the following table:

1962	31,055,094
1963	34,160,603
1964	37,576,663
1965	41,334,329
1966	45,467,762
1967	50,014,538
1968	55,015,992
1969	60,517,591
1970	66,569,350

It may now be seen that the estimated total actual production of 32,000,000 bags in 1965 will still be about 9,000,000 bags short of the estimated requirement for that year. This means that the immediate erection of the plant envisioned in this project study will cover only 60% of the supply shortage estimated for that year. This also means that even if a plant of the size proposed in this project study were to be built every year for five consecutive years starting with the present year, all these five plants of 4,500 barrels daily capacity each will not yet be sufficient to cover the expected growing cement shortage in the Philippine market. It is hoped that the foregoing analysis will show the tremendous scale and possibilities of the cement market in the Philippines.

Inspection of the following table will further show that the assumption of the 10% increment in the annual cement requirement is closely accurate. It may be seen that the increase in actual consumption, which of course is very much below the cement demand, approximately follows the same pattern of increment.

TABLE NO. III

Year	Production	Importation	Total actual consumption	consumption based on 10% annual increment starting from 1951
1951	7,403,708	250,781	7,654,489	7,654,489
1952	7,423,088	455,988	7,879,076	8,419,938
1953	6,964,740	679,678	7,644,418	9,261,932
1954	7,433,440	1,905,570	9,341,010	10,188,125
1955	9,586,692	829,108	10,415,800	11,206,937
1956	9,596,515	1,389,582	10,986,097	12,327,631
1957	10,461,563	3,462,532	13,924,095	13,560,394
1958	5,892,246	612,156	6,504,402	14,916,433
1959	14,679,910	1,033,276	15,713,186	16,408,076
1960	13,587,560	28,753	13,616,113	18,048,884
1961	17,511,402	21,688	17,533,090	19,853,772
1962	22,482,286	50,191	22,532,477	21,839,149

Although it is admitted that the assumed 10% annual increment cannot be carried indefinitely as a time will come when the cement demand has to level off, that time is certainly still very far off, considering that, economically, this country is just beginning to climb to the level of more advanced countries. It maybe worthwhile considering that in the year 1953 while the Philippines, with a population of about 20,000,000 produced only 7,644,418 bags, Japan with a population of about 90,000,000 produced 219,422,338 bags, and the United States with a population of about 150,000,000 produced 1,043,514,140 bags. This means that in that year each person in the Philippines used only about 3/8 of a bag, while each Japanese used 2.5 bags and each American used 7 bags. In 1962 the Philippines produced 22,482,286 bags for a population of about 28,000,000, or a per capita consumption of about 0.8 of a bag. From these figures we can readily see that each Japanese consumed three (3) times as much cement in 1953 as each Filipino did in 1962. The Americans consumed about 9 times in 1953 as the Filipinos did in 1962. It is hoped that these figures will show how far away the Filipinos still are from the levelling off point or saturation point as far as cement requirement is concerned. This means that the 10% annual increment can still be carried up for the next several years.

Aside from the local market, the satisfaction of which appears to be still in the distant future, the possibilities of the export market are also very encouraging. The cost analysis in Part V will show that the cement produced in the proposed plant can favorably compete with cement produced by the nearest rival producers of the Philippines — Japan and Taiwan. Taiwan which has offered the Philippines the lowest-priced imported cement, sells the commodity at $16.00 per metric ton CIF Manila. This is equivalent to about ₱2.70 per bag which is not too low a price considering the fact that the production cost in this prospective plant will be below ₱2.00 per bag. It should also be taken into consideration that the Philippines is the nearest cement producer to the potentially vast markets of Indonesia, Malaya, and the former French colonies in Indo-China. Although these countries are just as rich as the Philippines in cement raw materials, their expansion in this industry is stunted by the lack of good roads and other means of communication hence, they will remain for some time as good potential markets for cement producing neighbors among which will be the Philippines after she shall have solved her own cement shortage.

PART III

THE RAW MATERIAL DEPOSITS AND PLANT SITE:

(a) Location:

The proposed sources of raw materials and the plant site are situated in the Barrios of Biga and Calangahan in the municipality of Lugait, Province of Misamis Oriental, in northern Mindanao. The properties will consist of two groups of claims both of which are along the national highway running between the cities of Iligan and Cagayan de Oro. The first group of three (3) claims of 64 hectares each are located in the Barrio of Biga forming a rectangle of 1,200 meters x 1,600 meters with the 1,200-meter side running along the highway and symmetrically straddling the government milestone marked "Km. 55". The 1,600-meter sides run thenceforth eastward to the mountains. The other group of three (3) 64-hectare claims consists of three (3) 800-meter squares with two (2) of these squares lying side by side along the national highway and their two (2) connected sides, making a total of 1,600 meters, running northward from the government milestone marked "Km. 56". The third square lies adjacent to the first two, straddling both on their eastern sides. A topographical map of these claims is shown in the Appendix at the end of this study.

The plant site can be located in both groups of 3 claims. The technical team's choice is shown as plant site No. 1 which is located in the first group of claims mentioned above. The other group of 3 claims contains the second choice for a plant which is labelled plant site No. 2. Plant site No. 1 is located on a rolling limestone plateau with an average elevation of about 10 meters above sea level. This site overlooks the national highway by about 5 meters, the highway having an average elevation of 5 meters. Plant site No. 2 which may be considered an alternate of plant site No. 1 is located on a plain with an average elevation about as high as the national highway or only 5 meters. Perhaps the only other possible disadvantage of plant site No. 2 aside from the lack of an open stream is that, although it is expected that the subsoil is mainly limestone due to the presence of a limestone table along the shore, the soft organic top soil may be somewhat thick as shown by the healthy vegetation in this area.

Water is available from the Lugait river which is approximately 1 kilometer from plant site No. 1. It may also be available by deep well pump since the water table is known to be not very far from the surface in this area and the supply is also known to be plentiful. Plant site No. 2 has to depend exclusively on the deep well for its water supply since there is no known open stream nearby. There is no need to worry, however, about the quantity since underground water is known to be plentiful in this area.

The proposed transmission line of the National Power Corporation according to the plans of that government entity will be located at a distance of about 2 kilometers from either plant site. This transmission line which carries electricity at 69,000 volts can easily supply our plant's requirement of approximately 5,000 KW.

As to harbor facilities, it is believed that a good pier can be cheaply erected at the seashore opposite either plant site. Although this place is not as well sheltered from the northeast monsoon as the government pier in Kiwalan cove, it appears to be better sheltered than the piers in Iligan City itself. If it will not be found advisable to construct a pier in front of either plant site, at least a jetty for the bunker fuel oil, and possibly also for a cement bag conveyor for loading cement to ships, may be constructed while all other cargoes may be handled at the Kiwalan pier about 9 kilometers to the south from plant site No. 1. (b) Preliminary Geological Survey:

The first group of 3 claims which are called the "DOC", "KID" and "BEN" claims have elevations ranging from 2 to 66 meters from the sea level with the average elevation at approximately 30 meters. The other group of claims to the north called the "FRANK", "JOST" and "RIC" claims have elevations ranging from 5 to 55 meters, the average being approximately 25 meters. If all the claims were to be levelled to the elevation of the plant site No. 1, the raw materials available from these 6 claims would amount to: 10,000 x 192 x (30 — 10) + 10,000 x 192 x (25 — 10) = 67,200,000 cubic meters. If the same claims were to be levelled to the level of the road, the total raw materials available would be: 10,000 x 192 x (30—5) + 10,000 x 192 x (25 — 5) = 86,400,000 cubic meters. If the same claims were to be brought to the sea level, the raw materials available would then be: 10,000 x 192 x 30 + 10,000 x 192 x 25 = 105,600,000 cubic meters.

Since the specific gravity of compact limestone and cement rock is approximately 2.7 the raw materials available would then be as follows: 67,200,000 x 2.7 = 181,440,000 MT. if carried to the level of the plant site No. 1, or 10 meters elevation above sea level. If carried to the level of the national highway or 5 meters above sea level the raw materials available would then be: 86,400,000 x 2.7 = 233,280,000 MT. If the claims were to be levelled down to the sea level the raw materials available would be 105,600,000 x 2.7 = 285,120,000 MT.

Considering that the proposed plant will consume about 1,250 MT. of raw materials per day (assuming a loss on ignition of 40%) and basing on the standard assumption of 300 production days per year, the yearly requirement of raw materials would be 375,000 MT. This means it would take more than 480 years to bring these claims to the elevation of plant site No. 1, or 10 meters; more than 620 years to bring them to the level of the national highway, or 5 meters; and 760 years to bring them to the sea level. These calculations are of course based on the possibility that the whole mountain down to sea level is acceptable cement raw materials. The veracity of this assumption will be proven or disproven by the drilling operation which will be undertaken very soon. This assumption, however, may not be far-fetched if we consider, that for several kilometers along the shore, the limestone tables extend several meters beyond the shore line and much under the sea level. For purposes of the initial installation, the survey team recommends the acquisition of the title of only about 100 hectares around and including plant site No. 1, and also including about 10 hectares in the "RIC"claims and the right-of-way thereto. This initial area should be good for, at least, 50 years at the initial capacity of the proposed plant.

The raw material deposits exist in forms varying from massive limestone to the clayey coralline forms whose major composition swings from mainly calcereous to mainly argillaceous, from the view point of the correct cement rock composition considered ideal for kiln-feed. These materials are found in 5 of the 6 claims, while the siliceous shale is found only in the "RIC" claim. As stated in the succeeding section it will be found that the maximum shale requirement will only be about 12.6% which means that this one shale claim is more than enough to balance the 5 limestone claims.

(c) Chemical Evaluation:

Since core drilling is an expensive and long operation which would take some time before this study could be made, and since the surface indications, based on past experiences of the survey team in this area, are considered convincing enough to assume sufficiency and consistent uniformity of the raw materials, this project study has been prepared with the idea that the core drilling operations will be made later to confirm the assumption made herein. As an expedient substitute for core drilling, the survey team adopted the method of "channel sampling", that is getting samples at different elevations in approximately vertical sections by digging vertical channels deep enough to eliminate the weathered surface of the nearly-vertical sections. Following this method of sampling, 3 limestone samples and 1 shale sample were obtained from the "DOC", "KID" and "BEN" claims, 8 limestone samples were obtained from the "FRANK" and "JOST" claims, while 1 shale sample was obtained from the "RIC" claim. The shale in the "RIC" claim being in the form of massive boulders, the chemical composition is practically uniform so that multiplicity of samples was considered unnecessary. From the analyses of these 13 samples, 4 preliminary theoretical mixes were obtained which are also shown below. This preliminary theoretical mixes consist of 2 binary or 2-phase blends and 2 ternary or 3-phase blends. It may be seen that the theoretical clinkers fall very well within the ASTM and other internationally accepted standards. This theoretical trial mixes are not the only ones available from the analyses of the raw materials obtained . Other combinations may yet be obtained upon a longer study of these analyses and those of other samples which may yet be obtained. The analyses of the samples and the theoretical mixes derived therefrom are shown below:

SITE NO. I . (DOC, KID & BEN claims)

	Sample Nos.			
	1	2	3	4
1. Loss on ignition	39.47	34.42	30.46	11.90
2. Ca^0	48.94	41.96	37.52	9.38
3. Si^0_2	6.14	12.90	18.64	49.88
4. $Al_2{}^0{}_3$	3.51	6.72	8.10	17.16
5. $Fe_2{}^0{}_3$	1.51	2.52	2.68	7.22
6. Mg^0	0.72	1.05	2.09	2.37
7. CaC^0_3	85.6	69.5	63.8	10.9

SITE NO. 2 (FRANK, JOST & RIC claims)

	Sample Nos.			
	1	2	3	4
1. Loss on ignition	40.17	39.05	34.15	34.25
2. Ca^0	49.54	48.52	41.84	40.68
3. Si^0_2	5.54	6.52	14.76	15.36
4. $Al_2{}^0{}_3$	1.84	2.27	5.38	5.56
5. $Fe_2{}^0{}_3$	1.70	1.49	1.07	2.52
6. Mg^0	0.91	ND[*]	ND	ND
7. CaC^0_3	88.53	87.12	ND	72.40

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[*] Not determined

Continuation of SITE NO. 2:

	5	6	7	8	9
1. Loss on ignition	35.56	32.88	26.35	26.31	6.48
2. Ca^0	40.18	36.08	33.08	30.58	3.92
3. $\text{Si}^0{}_2$	13.98	18.26	25.34	28.00	64.94
4. $\text{Al}_2{}^0{}_3$	5.94	6.70	9.35	8.95	16.20
5. $\text{Fe}_2{}^0{}_3$	3.62	3.62	1.73	2.03	5.38
6. Mg^0	ND	ND	ND	ND	1.22
7. $\text{CaC}^0{}_3$	71.19	64.73	ND	ND	0.6

PRELIMINARY THEORETICAL MIXES

Theoretical Mix No. 1

87.43% Sample 1 — Site No. 1
+ 12.57% " 9 — " No. 2

	Theoretical Kiln Feed	Theoretical Clinker
Loss on ignition	35.3	—
Ca^0	43.281	66.90
$\text{Si}^0{}_2$	13.531	20.92
$\text{Al}_2{}^0{}_3$	5.105	7.89
$\text{Fe}_2{}^0{}_3$	1.996	3.08
Mg^0	0.783	1.21
$\text{CaC}^0{}_3$	74.9	—

Theoretical Mix No. 2

77.10% Sample 1 — Site No. 1
+ 11.45% Sample 2 — Site No. 1
11.45% Sample 9 — Site No. 2

	Theoretical Kiln Feed	Theoretical Clinker
Loss on ignition	34.891	—
Ca^0	42.986	66.29
$\text{Si}^0{}_2$	13.647	21.04
$\text{Al}_2{}^0{}_3$	5.330	8.22
$\text{Fe}_2{}^0{}_3$	2.069	3.19
Mg^0	0.816	1.26
$\text{CaC}^0{}_3$	74.6	—

PRELIMINARY THEORETICAL MIXES — Cont'd

Theoretical Mix No. 3

56.61% Sample 3 — Site No. 1
+ 43.39% Sample 2 — Site No. 2

	Theoretical Kiln Feed	Theoretical Clinker
Loss on ignition	34.187	—
Ca^0	42.293	65.08
$Si^0{}_2$	13.381	20.59
$Al_2{}^0{}_3$	5.569	8.57
$Fe_2{}^0{}_3$	2.163	3.33
Mg^0	1.578	2.43
$CaC^0{}_3$	73.9	—

Theoretical Mix No. 4

62.52% Sample 1 — Site No. 2
+ 30.0 % Sample 6 — Site No. 2
7.48% Sample 9 — Site No. 2

	Theoretical Kiln Feed	Theoretical Clinker
Loss on ignition	35.46	—
Ca^0	42.089	66.31
$Si^0{}_2$	13.80	21.74
$Al_2{}^0{}_3$	4.372	6.89
$Fe_2{}^0{}_3$	2.550	4.02
Mg^0	0.66	1.04
$CaC^0{}_3$	75.5	—

PART IV

PRELIMINARY DESIGN AND SPECIFICATIONS:

(a) Plant Site Design:

The recommendation of the survey team is to locate the plant site in the area marked "Plant Site No. 1" on the topographic map at the end of this study in such a way that the kiln will be located alongside the cut at the beginning of the rise from the 10-meter level to the 20-meter level after clearing part of the top soil on the 15-meter level. It is thought that this would put the kiln, the mills, and the crusher on very solid footings. The crusher should be placed such that the raw materials, in the initial stages of the operation, could just simply be pushed into its feed bin by a bulldozer or by a loader. The western and southern portions of the plant site should contain the smalller buildings of the plant, such as the administration buildings, chemical laboratory, maintenance shops and the guest house. A thorough subsoil investigation should be made during the engineering phase of this project. Proper grading, landscaping and beautification can also be made without much extra expense on this site.

(b) The Plant Equipment and Essential Structures:

The following is a tentative general preliminary design of the proposed cement plant. The figures and specifications stated herein are to be taken only as general guides subject to final adjustment in the final engineering design to be done by a staff of competent engineers.

OPERATING SCHEDULES AND EQUIPMENT CAPACITY DATA FOR A 4,500-BBL. PER DAY WET PROCESS CEMENT PLANT

1. QUARRY SECTION:

Working schedule: 8 hours per day x 5 days per week

Capacity: $\frac{1,250 \times 7}{40} = 219$ or say 250 MT. per hour.

Recommended equipment:

1-1 Power Shovel, complete
Requirement: 2 sets

Type:	Northwest or equivalent
Capacity:	2½ cu. yd. or 2.0 cu. m.

	Engine Drive:	Caterpillar Diesel or equivalent One of the sets to be convertible into a crane by providing a 100-ft boom complete with sheaves, hookblock and cables to replace the shovel front and dipper when so needed.
1-2	Bulldozer-Ripper Tractor:	
	Requirement: 1 set	
	Type:	Caterpillar D-9 or equivalent, complete with cable controlled bulldozer and hydraulic controlled ripper.
1-3	Bulldozer-Ripper Tractor:	
	Requirement: 1 set	
	Type:	Caterpillar D-8 or equivalent, complete with cable controlled bulldozer and hydraulic controlled ripper.
1-4	Front End Loader:	
	Requirement: 1 set	
	Type:	Caterpillar traxcavator 977 or equivalent.
	Capacity:	2½ cu. yd.
1-5	Dump Trucks:	
	Requirement: 3 units	
	Type:	Euclid, Le Tourneau Haulpak or equivalent.
	Capacity:	22 tons
1-6	Stationary Air Compressor:	
	Requirement: 2 sets	
	Type:	Ingersoll Rand, Chicago Pneumatic or equivalent
	Working pressure:	150 p.s.i.
	Capacity:	1,000 cfm
	Electric motor drive:	200 H.P.
1-7	Portable Compressor:	
	Requirement: 1 set	
	Type:	Ingersoll Rand, Chicago Pneumatic or equivalent

Working pressure: 150 p. s. i.
Capacity: 400 c.f.m.
Diesel Engine Drive: 100 H.P.

1-8 Hand Drill:
Requirement 12 sets
Type: Ingersoll Rand, Chicago Pneumatic or equivalent
Weight of Hammer body: 60 lb. class, complete with accessories.

1-9 Drill Sharpener:
Requirement: 1 set
Maximum Diameter of drill: 3 inches, complete with accessories.

2. CRUSHER SECTION:

Working schedule: 8 hours per day x 5 days per week.
Capacity: $\frac{1{,}250 \times 7}{40} = 219$, or say 250 MT. per hour.

2-1 Raw Material Hopper:
Requirement: 1 set
Size: 20 x 12 ft. x 15 ft. high with liner

2-2 Chain Feeder:
Requirement: 1 set
Capacity: 250 MT. per hour
Electric Motor Drive: 15 H. P. geared motor

2-3 Preliminary Crusher:
Requirement: 1 set
Type: Jaw Crusher
Capacity: 250 MT. per hour
Intake Opening: 75 inches maximum
Output: Minus 4 inches
Electric Motor Drive: 225 H. P.

2-4 Belt Conveyor:

Requirement: 1 set

Type: Trough type

Capacity: 250 MT. per hour

Electric Motor Drive: 15 H. P. geared motor

2-5 One apron feeder 80" wide, 480" center distance.

—Design: Slats of 5/16" thick steel plate reinforced by 15/8 x 15/8" squares, connected through 2" steel shaft acting as hinges, star shaped operating head with grease lubricated bearings and shafts supporting frame made of rolled shapes.

—Drive: 30 HP variable speed gear motor, with pertaining automatic control equipment in connection with the load of crusher motor; electro-magnetic coupling; speed gear - reducer in water tight casing; flexible coupling; couple of idle gearwheels.

—Accessories: lateral guide walls 13/16" thick steel plate feeding inlet; servicing platform with ladders.

—Drive motor 30 HP, 1450 r.p.m.

2-6 One hammer crusher, dia. of beater system about 100".

—Intake opening: 75" x 75"

—Design: crusher case made of two welded steel plate walls, 1.6" thick, and two cast steel wear resisting jaws; steel shafts on three ring type self-lubricated bearings; rotor composed of CrVa forged steel wheels; 48 hammers, 12+14% Mn steel, 75 kgs each, removable grid with wear resisting steel bars.

—Drive: by means of "V" belts, drive pulleys at the same time designed as fly-wheels.

—Drive motor 450 HP, 975 r.p.m.

2-7 One troughing belt conveyor, 32" belt width, 100 m horizontal center distance, 20 m vertical distance, 18° slope, for 250 tons per hour of crushed limestone, max. grain size 7/8".

—Design: head terminal, with snubbed pulley drive, shafts and bearings-vertical gravity take up-foot terminal with pulley, shaft and bearings-upper three-part throughing roller stations, with passing steel axles and dust-tight incorporated ball bearings-lower roller stations, of same design — the necessary frame-work structure 40" high, for receiving and supporting all above specified parts — the cleaning apparatus, feeding device and discharge chute — the rubber belt 32" wide. The steel underframe of the conveyor is 40" high and is based on a r.c. structure. Possible roofing and side protection are excluded too.

—Drive: gear speed reducer with two flexible connection couplings.

—Drive motor 50 HP, 1460 r.p.m.

3. RAW MILL SECTION:

Working Schedule: 20 hours per day x 7 days per week.

Capacity: $\frac{1,250 \times 7}{140} = 62.5$ MT. per hour, or say 70 MT. per hour.

3-1 One clay-slurry feeder.

—Design: Constant level case of welded steel plate with overflows at adjustable heights, tray type rotor with central discharge, overhung on a shaft resting on antifriction bearings.

—Drive: sheaves and "V" belts, reducing gear with precision gears in a oil-tight casing, flexible coupling metering.

—Accessories: metering basin with counterweight bottom valve.

—Drive motor 3.6/1.2 HP variable speed 1350/450 r.p.m. complete with electric remote control equipment.

3-2 One weighing and metering equipment for limestone and additive material, consisting of: two 24" — inch Poidometer machines, 8'7" pulley centers, as follows:

—one to continuously feed 12 to 70 ton per hour of limestone 3/4" max. lump.

—one to continuously feed 0.5 to 3 ton/h of additive, 0 to 3/4" max. lump.

Each of the above poidometer to be furnished with a dustproof variable speed motor, 1-1/2 HP, constant torque, single winding, weighing recorder with contactors for remote control, 24" wide rubber belt.

The above equipment will be complete with hoppers, slide gates, supports and motor starting equipment.

3-3 One two compartment compound mill for wet grinding raw materials.

—Mill tube: 3 m inside dia, 12 m length, 1-3/8" thickness of plates, automatically welded, stress-relieved in furnace.

—Shell and end liner: 12+14% manganese steel.

—Trunnion bearings: spherical seat design, oil lubricated and water cooled.

—Main drive: spur gear rim of welded steel, pinion of forged steel, pinion shaft of forged steel mounted in oil lubricated bearings, speed reducing gear, with a pair of steel helical teeth gears, closed construction, forced lubrication; two flexible couplings; speed ratio 375/165 r.p.m.

—Auxiliary drive: bevel and spur-wheel gear with mounted recoil brake, and couplings.

—Accessories: greasing device, discharge and screening device; slurry collecting hopper.

—Drive motors main drive 1700 HP, 375 r.p.m., auxiliary drive 20 HP, 720 r.p.m.

3-4 Chutes and slides.

—Design: steel plate and section iron, cleaning openings, wear plates as far as necessary.

4—RAW SLURRY TRANSPORT SECTION:

4-1 Two slurry centrifugal pumps, each 1,500 liter per minute delivery.

—Design: Pump casing with opening lid; pump base with bearings; wear resisting impeller, cantilever assembly on steel shaft supported by two ball bearing; water washed packing.

—Drive: flexible coupling.

—Drive motors 2 x 45 HP, 1460 r.p.m.

4-2 Two slurry transfer centrifugal pumps, each 1,500 liters per minute delivery.

—Design and drive as per item 4-1

—Drive motors 2 x 45 HP, 1460 r.p.m.

4-3 Two slurry feed centrifugal pumps, each 1,000 liters per minute delivery.

—Design and drive as per item 4-1.

—Drive motors 2 x 40 HP, 1460 r.p.m.

4-4 a) 20,000 lbs. steel pipes, not bent, with flanges, bolts and sealing, for slurry

b) 5 pcs. 6", 6 pcs. 5", 18 pcs. 4", special slurry valves.

c) 58 pcs. 3/4" water valves for washing the above mentioned valves.

5—HOMOGENIZING OF SLURRY SECTION:

5-1 a) Four slurry mixers for basins 26'-3" dia, 29'-6" depth.

—Design and drive as per item 2-3.

b) One device for automatic delivery of compressed air to the clay and slurry basins including:

—One impulse sequence time cycle controller.

—Six diaphragm valves, 4".

—Six solenoid valves.

—One air pressure reduction valve with filter.

—Copper tubes and connecting electric cables.

—One dust tight locker for the instruments.

5-2 Two pneumatic mechanical agitators, with compressed air blower, for a storage tank 82 ft. dia, 14'-9" useful depth, 70,000 cu. ft. capacity.

—Design: slewing bridge supporting frame of steel plates and sections, fitted with a pair of wheels for sliding at one end, and with a support on antifriction bearings at the other end, three vertical pneumatic mechanical agitators supported by above mentioned frame by supports with antifriction bearings, driving gears for the bridge and the agitators rotation, cables and electric equipments to be mounted on the slewing bridge; automatic compressed air distributor; pipes with flanges and bolts for the compressed air and the slurry; pipe supporting and service gang-way; sliding rails with respective accessories; inspection hole and fittings for the tank.

—Drive motors for the bridge rotation 2 x 10 HP, 1440 r.p.m.

—Drive motors for the agitators rotation 2 x 12.5 HP, 1440 r.p.m.

5-3 Three air compressors, 4 vertical cylinders, single acting, water circulation cooling, complete with suction filter, lubrication pump, sheaves, V belts and accessories, each about 5.000 cu. ft. of air per minute capacity and 4 ate pressures.

—Drive motors 3 x 125 HP, 980 r.p.m.

5-4 One compressed air tank, 350 cu. ft. capacity.

—Design: welded steel plates.

—Accessories: two safety valves, one drain valve, one pressure gauge, two stop valves.

5-5 10,600 lbs. steel pipes, not bent, with flanges, bolts, sleeves, and gaskets for ditto.

5-6 Two centrifugal water pumps, complete with valves, accessories.

—Drive motors 2 x 15 HP, 1450 r.p.m.

5-7 33,000 lbs. steel pipes, not bent, with flanges, bolts, sleeves, valves and gaskets, for cooling water distribution and slurry transferring.

6. KILN SECTION:

Working Schedule:	24 hours/day x 7 hours/week
Capacity:	750 MT/day

6-1 One slurry feeder.

—Design, drive and accessories as per item 3-1.

—Drive motor 3.6/1.2 HP variable speed D.C. motor, 1000/330 r.p.m., complete with electric remote control equipment and device for speed synchronizing with kiln drive motors.

6-2 One rotary kiln, wet process, with internal heat exchangers.

—Kiln tube: 13' x 12' x 13' inside dia, 560' length, 1-3/16" thickness of plates, 1-3/16" in the sintering zone, 2-3/8" underneath tyres, 1-5/8" underneath girth gear, automatically welded; with nose ring aircooled discharge, and feed head ring in heat resisting alloy steel.

= 7 tyres of cast steel.

=14 rollers, 60" dia, 24 ins. wide, of cast steel, running in water bath.

=28 bearings, spherical seat design, with automatic oil lubrication and water cooling.

=Thrust roller pedestal with two rollers for limiting longitudinal movement of the kiln.

—Main drive: Elastically fixed girth gear and two pinions of special steel, machine cut teeth with shafts and four support bearings, automatic oil lubrication, two triple reducing gears with helical tooth gears, of the closed type, with automatic oil lubrication; four flexible couplings.

—Auxiliary drive: two 50 HP Diesel engines with gear reducers 1500/85 r.p.m. hydraulic couplings and accessories.

—Accessories:

=one firing hood with four wheels and rails.

=one feeding pipe of heat resisting steel protected by a chrome cast iron liner.

=two single floating type air seals for inlet and outlet end of the kiln tube.

=one cooling electrical fan end with 5 HP motor.

=one set of special inside heat exchangers to be fitted in the kiln drying zone.

=one set of heat exchanger chain strings and respective connecting pieces for a total weight of about 130,000 lbs.

—Drive motors: two 175/58 HP D.C. motors, 1000/330 r.p.m., and two Diesel auxiliary engines 50 HP 1500 r.p.m.

6-3 One sloped grate cooler.

—Design: section steel frame lined with steel plates on all sides, with inspection doors and accessories — rocking frame for grate support, resting on sliding rollers with plate holders — grate plates of chrome-nickel cast steel in the hot zone and of special heat and wear resisting cast iron elsewhere — lateral wearing plates of special cast iron — discharge grating — grate frame with connecting rod intermittent conveyance of the material — centrifugal fan for cooling air — 10" to 7" thick fire resisting lining, complete with hanging guides, screws, fossil meal plastic insulation — fittings—pipings with shutters and stack.

—Two built-in hammer crushers.

—Heat control board.

—Drive:

=for the grate: motor speed changing gear, 15 HP, with automatic remote control by means of taster pyrometer;

=for the chain conveyor: 6 HP motor reducing gear.

=for the fan: a pair of sheaves with V belts.

=for the crusher: a pair of sheaves with V belts.

—Drive motors:

=15 HP, 1450 r.p.m. for the grate.
= 5 HP, 1450 r.p.m. for the chain.
=32.5 HP, 1450 r.p.m. for the primary fan.
=70 HP, 1450 r.p.m. for the secondary fan.
=two 10 HP, 1450 r.p.m. for crushers.

6-4 Smoke box with four dust collecting hoppers of steel plate and section, with four explosion doors of cast iron, two inspection doors, four dampers with screw and hand wheel for dust discharge.
Smoke box outline dimensions: about 15' x 20' x 25'

6-5 a) One centrifugal exhauster.

—Design: spiral casing of welded steel plates bolted with changeable plates, impeller with blades of wear resistant steel plates, dynamically balanced; air cooled steel shaft.

—Supports: two antifriction supports with grease lubrication.

—Drive: V belt drive with two sheaves.

—Drive motor: 200 HP, 960 r.p.m.

b) One main damper with electric servomotor for remote control.

c) One by-pass damper with counterweights and hand operated winch.

6-6 Steel plate flues with expansion joints, springs suspensions, flanges, bolts and packings.

6-7 Chimney of steel plates, 10' dia, 82' high, complete with ladder, stay wire, foundation bolts and accessories.

6-8 One heat control board consisting of:

—One locker type board of finely painted steel plate, with side access dooor, dust tight.

—Equipment for analysis and indication of 0_2 in the fumes.

—Equipment for analysis and indication of CO_2 in the fumes.

—Equipment for analysis and indication of $CO + H_2$ in the fumes.

—Equipment for temperature indication of the fumes at kiln outlet with optical and acoustic alarm signal.

—Equipment for temperature indication in the kiln medium zone.

—Equipment for vacuum indication in the fumes.

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on antifriction supports, a double chain, welded steel plate buckets, limit switches and counter weights.

—Drive: speed reducing gear, flexible coupling, a pair of sprockets and driving chain, not return brake.

—Drive motors: 2 x 40 HP.

9-5 7' x 10' of airslides to convey 150 t/h of cement from bucket elevators item 12-4 to the air separators item 12-6.

9-6 Two whirlwind centrifugal air separators 16' dia., provided with inward cement cooling devices, V belt drive.
—Drive motors: 2 x 125 HP.

9-7 a) 41' of airslides to convey 250 t/h of cement from separators item 9-6 to mill item 9-2, complete with electric fan 875 c.f.m. capacity, 5.5 HP, 2850 r.p.m.

b) 50' x 26' of airslides to convey the cement from separators item 9-6 to the cement pump.

c) 40' of airslides to convey the cement from filters item 9-8 a to airslides item 9-7 b.

9-8 One dust collector unit consisting of:

a) Two automatic bag type dust collectors, with shaking mechanism and accessories.

b) One electric fan 26,250 c.f.m. capacity. Drive motor: 60 HP.

c) Two cyclone type separators of steel plates.

d) 10,000 lbs. dedusting pipes of steel plates, complete with throttle valves and cleaning orifices.

9-9 One mill control panel, complete with the required instruments for controlling the feeder deliveries and the cooling air temperature and accessories.

10—GYPSUM CRUSHING SECTION:

Working Schedule: 8 hours/day x 5 days/week

Capacity:

$$\frac{750 \text{ x } 0.04 \text{ x } 7}{40} = 5.25 \text{ or say } 10 \text{ MT/hour}$$

10-1 One apron feeder, 32" wide, 160" center distance.
—Design and drive as per item 9-1.
—Drive motor: 5 HP, 1430 r.p.m.

10-2 One impact crusher, intake opening 14" x 26", dia., 30", width 27".
—Design and drive as per item 9-2.
—Drive motor: 20 HP, 1460 r.p.m.

10-3 One bucket elevator, 10 t/h capacity, 36' center distance.
—Design and drive as per item 9-3.
—Drive motor: 5 HP, 1430 r.p.m.

11—CEMENT TRANSPORT SECTION:

11-1 a) One cement rotary pump, 60 t/h capacity for conveying cement from mill department to silos, complete with loading hopper, rotary valve, base and couplings.
Drive motor: 90 HP, 750 r.p.m.

b) One rotary air compressor for pneumatic conveyance of cement, complete with suction filter, water and oil separator, and couplings.
—Drive motor: 130 HP, 735 r.p.m.

c) Ml. 175 Straight seamless steel pipes, 8" dia., with flanges and bolts for connecting the rotary pump to the cement silos.

d) Three deflector valves, fitted with remote control servomotor.

11-2 Four level indicators to indicate the "full" for the cement silos.
One control and signalling panel.

11-3 Pneumatic equipment for discharging cement storage silos by means of air slides to be arranged in the silos bottom, consisting of:

a) 13' x 360' running feet long airslides, 6 to 8^0 slope, complete with the required connecting branches, tubes and junction sleeves.

—2 DN. 150 air distributors, 15" x 2" = 1" x 1" control cocks.
—13 x 7 running feet airslides.
—4 x 2 junction plates to the silos.
—4 x 2 valves.
—4 x 2 layer depth adjusting devices.
—4 x 2 lateral discharge boxes.
—4 x 2 discharge heads.

b) No. 2 rotary air compressors for a delivery of 378 c.f.m. and a working pressure of 160" H_2^0, complete with silencer, suction filter, safety valves, spring joint for coupling to the motor, base for the compressor and the motor.

—Drive motors: 2 x 20 HP, 950 r.p.m.

c) One rotary air compressor as above, however for a delivery of 655 c.f.m. and a working pressure 160" H_2^0.

—Drive motor: 30 HP, 1450 r.p.m.

11-4 7 x 100 running feet of airslides for the pneumatic conveyance of 90 t/h of cement from the silos to the herein-after mentioned bucket elevators, complete with deaerating opening, two spy holes, one end closing plate, a discharge head and two high pressure electric fans for 875 c.f.m., 20" H_2^0, including two 5.5 HP at 2850 r.p.m. motors.

11-5 Two bucket cement elevators, 90 t/h capacity, 73' center distance.

—Design: casings with steel plate and section steel head and footing — driving and idler wheels of cast iron fitted on steel shaft revolving on antifriction supports, a double chain, welded steel plate buckets, limit switches and counterweights, speed reducing gear, spring joint for coupling, a pair of sprockets and driving chain, not return brake.

—Drive motors: 2 x 30 HP, 1460 r.p.m.

11-6 One dust collector unit, consisting of:

a) Two automatic bag type dust collectors, for dedusting the silos blow-off air, with shaking mechanism, and accessories.

b) Two electric fans for a maximum capacity of 2,800 c.f.m.
—Drive motors: 2 x 7.5 HP, 2850 r.p.m.

c) Dedusting pipes of steel plates with throttling valves.

12—PACKING PLANT.

Working Schedule: 8 hours/day x 5 days/week

Capacity: $\frac{750 \times 7}{40} = 131.25$ or say 150 MT/hour.

12-1 Two single deck dust proof ME 1200 x 2500 type vibrating screens with a screening surface of 40" x 80" fitted with screening cloth of high quality, 5/32" opening and 1/16" dia. wire, with springs type suspensions, 4 rubber sleeves fastening string for the inlets and outlets of the screen.

Drive: V belt and drive pulleys.

Drive motors: 2 x 5 HP, 1430 r.p.m.

12-2 Two 180" x 120" x 200" storage bins.

Design: 2/32" steel plate with reinforcement and holdings.

Accessories: Two bin level indicators with cast iron housing, 4 gate valves 16" x 20", 4 rotary feeders, 14" dia., 20" length of the cells, each required gear and drive motor 1.5 HP.

12-3 Two BBV type automatic packing machines, with 6 filling spouts for packing cement into self closing valve type jute or paper bags, 50 kg. gross, with automatic filling control.

Drive: with grooved pulleys and V belts.

Accessories: 1 totally enclosed packing hopper with inlets and air suction spouts, two bin level indicators, pre-compacting chamber consisting of electro-magnetic exciters and vibrating cells.

One control panel containing the electric control system for the fully automatic operation of the packing plant, included electric apparatus, wiring and transformer but without the electric leads from the control panel and the packer hopper.

Drive motors: 4 x 25 HP, 960 r.p.m.

12-4 One dust collector unit consisting of:

a) Two automatic bag type dust collectors, with shaking mechanism and accessories.

b) Two electric exhaust fans,
—Drive motors: 2 x 35 HP, 1450 r.p.m.

c) 5,000 lbs. dedusting of steel plates with throttling valves and cleaning openings.

13—TRANSPORT PLANT FOR FILLED BAGS:

Working Schedule: 8 hours/day x 5 days/week

Capacity: $\frac{750 \times 7}{40} = 131.25$ or say 150 MT/hour

13-1 Two horizontal wire cloth conveyors — 30" belt width, 160" center to center distance.

—Design: framework with supports for a height of 56", driving and tension pulleys 16" dia., with wooden bandages, 7 upper and 3 lower flat idlers 4-1/4"/5-9/32" dia., with rubber rings.

—Drive speed gear reducers: 2 x 3 HP, and flexible couplings.

—Drive motors: 2 x 3 HP, 1430 r.p.m.

13-2 Two packing platforms 120" x 120", 100" height, with adjustable gangway, staircase and grates.

13-3 One horizontal flat belt conveyor, 30" belt width, 86' 8" center to center distance.

—Design: framework with supports for a height of 56", driving pulley 20" dia., shaft 2-3/4" dia., tension pulley 16" dia., shaft 2-3/8" dia., 40 upper and 12 lower flat idlers 4-1/4" dia. and supports.

—Drive speed gear reducer and flexible couplings.

—Drive motor: 5 HP, 1430 r.p.m.

13-4 One horizontal flat belt conveyor, 30" belt width, 60' center to center distance.

—Design: as per item 13-3.

—Drive speed gear reducer and flexible couplings.

—Drive motor: 5 HP, 1430 r.p.m.

13-5 One horizontal flat conveyor, 26" belt width, 75' center to center distance.

—Design: as per item 13-3.

—Drive motor: 5 HP, 1430 r.p.m.

—Drive speed gear reducer and flexible couplings.

13-6 One horizontal flat belt conveyor, 26" belt width, center to center distance.

—Design: as per item 13-3.

—Drive speed gear reducer and flexible couplings.

—Drive motor: 5 HP, 1430 r.p.m.

13-7 No. 8 bag diverters, for flat belt conveyors items 13-3 to 13-6 for the transport of filled bags to the wagons and lorry loaders, with belt conveyor 7" belt width, 5' center to center distance, inclusive rubber belt and gear motor of 0.75 HP.

13-8 No. 4 bag chutes of 5/32" iron sheet, at the side of the bag diverters item 13-7 for discharge of bags to the belt conveyors item 13-9, two of these chutes to be lifted up.

13-9 Two horizontal flat belt conveyors, 26" belt width, 246' center to center distance.

—Design: Framework with frame for the suspension of the belt conveyor, driving pulley 25-25/32" dia, shaft 3-25/32" dia., tension pulley 16" dia., shaft 2-3/8" dia., 116 upper and 27 lower flat idlers of 4-1/4" dia., 1 snub pulley 7-3/4" dia.

—Drive motors: 2 x 10 HP, 1450 r.p.m.

—Drive: two bevel gears and flexible couplings.

13-10 a) Two wagon loaders, movable in longitudinal and cross direction; 30" belt width, 10' center to center distance of the feed belt conveyor, and 6'3" center to center distance of the main belt conveyor.

—Design: framework and two sets of wheels for driving the entire wagon loader forward and backward, gear motor of 2.2 HP with pulleys and V belts, substructure for driving the entire wagon loader in cross direction inclusive of a gear motor of 2.2 HP with pulley and V belts, pulley motor of 3 HP, 8½" dia., 28" length, for the drive of the feed belt conveyor, upper and lower flat idlers 5-1/4" dia., with bearings and axes, tension and pulley 7-1/2" dia., one-pieces shaft and necessary bearings, endless vulcanized —rubber belt of 30" width, for a center distance of 10'.

Main belt conveyor with framework and device for driving forward and backward, inclusive motor of 1.4 HP with spindle, device for adjusting the belt conveyor in height with the spindle built-in and driving motor of 1.4 HP, with V belt drive turn device, pulley motor 8½" dia., 3 HP, 28" length, tension end pulley 7½" dia., upper and lower flat idlers and a rubber belt of 26" width for a c.c. of 6'3", the control switch for moving the entire wagon loader and one main switch.

b) Two diverting chutes for the transport of the filled bags from the bag divertes to the feed belt conveyor or the wagon loader.

c) Two portable bag diverting trolley for the bag discharge.

—Design: framework with 2 sets and wheels 10" dia., gauge 3'7", 3 flat idlers 3½ dia., 30" length, discharge table with 5 flat idlers in addition of 3½" dia., 26" length, the belt conveyor with belt 7" width, and 60" center distance; the two pulleys with vertical shafts, gear motor 0.75 HP; lateral chute; lateral guide rolls and support for the drive of the bag diverter.

d) Two gear motors each of 2.2 HP with V belts drive for the drive of the bag directing trolley.

13-11 For bag chutes of 5/32" iron sheet, at the side of the bag diverters item 13-7 for the discharge of the bags to the lorry loaders item 13-13.

13-12 a) Two portable lorry loaders, 26" belt width, 240" center to center distance.

— Design: tension end pulley 12-3/8' dia., 10 upper and 4 lower idlers; 5-1/4" dia., framework and 2 sets of wheels 8-9/16" dia., two rubber belts 26" width complete with two pulley motors each of 3 HP, 12-3/8" dia., and two gear motors each of 2.2 HP for the moving of the lorry loaders.

b) Two bag chutes from the lorry loaders with discharge table complete with two electro-tractors.

c) Two helical chutes of about 15' length with inlet and outlet piece, complete with support and two discharges.

13-13 a) Two horizontal spillage return screw conveyors, 10" screw dia., 240" length.

—Design: steel plate trough, shaft 2" dia., with wings inclusive drive support.

—Drive: two speed gear reducers and flexible couplings.

—Drive motors: 2 x 3 HP, 1430 r.p.m.

b) Two complete belt facings inclusive spillage return funnel for screw conveyor item 13-13 and wire cloth conveyor item 13-1 inclusive grates.

c) Two spillage return pipes 10" dia., 26' length inclusive connection frame.

14—ELECTRIC TRANSFORMERS, MOTORS, SWITCHGEAR AND DISTRIBUTION BOARDS

Power max. demand 5200 kVA.

14-1 a) Two three-phase oil cooled transformers, each one with the following main features:

—power	3500 kVA
—lag power factor	0.8
—transformer ratio	6600 ± 2.5% — 440 V
—frequency	60 cycles

Technical guarantees:

—no load losses	8.6 kW
—short circuit losses	42 kW
—short circuit tension	7%

b) One three-phase oil cooled transformer similar to above, for quarry service.

—Main features:

=power	700 kVA
=lag power factor	0.8
=transformer ratio	6000 ± 2.5% — 440 V
=frequency	60 cycles

Technical guarantees:

=no load losses	2 kW
=short circuit losses	9.5 kW
=short circuit tension	4.6%

c) One three-phase transformer, similar to above, for lighting system and general services.

—Main features:

=power	250 kVA
=lag power factor	0.8
=transformer ratio	440 ± 2.5% ± 5% — 230 V
=frequency	60 cycles

14-2 a) Electric equipment for the sub-station consisting of:

—1 three pole main isolating switch for feed line cutting out.

—3 single pole arrester for lines overvoltage protection.

—main control — checking and measure dust proof switchboard for transformer cabin, of steel sections and steel plates, cubicle type subdivided in No. 17 cubicles, No. 6 of which of H.T. type and the others of the L.T. type as follows:

=cubicle No. 1 H.T. line arrival instruments for checking and measuring the total power absorbed by the system.
=cubicle No. 2 for cable 6600 V feeding.
=cubicles No. 3-4 for 3500 kVA transformers, 6600 V.
=cubicles No. 5-6 for raw and cement mills feeding, 6600 V.
=cubicles No. 7-8 for 3500 kVA transformers return, 440 V.
=cubicles No. 9-10-11-12-13 for cement factory feeding, 440 V.
=cubicles No. 14 for 250 kVA transformer feeding, 440 V.
=cubicles No. 15-16-17 for 250 kVA transformer return.

b) Electric equipment for quarries consisting of:

—dust proof main switchboard of steel sections and plates for quarries service, cubicle type subdivided in 3 cubicles.

—cubicle No. 1 = 6600 V line arrival and 700 kVA transformer feeding.

—cubicle No. 2-3, return at 440 V from 700 kVA transformer and quarries power feeding.

—one dust proof panel for lighting feeding to the quarries containing one three-phase 250 kVA transformer, 440/230 V ratio, complete with automatic switches and measuring and control instruments.

c) Two dust proof switchboards of steel sections and steel plates for synchronous motor control, containing:

—3 pole automatic switch, in oil, suitable for hand and remote operation, remote motor protector to control the excitation device, field rheostat with control servomotor for the automatic adjustment of power factor, remote motor protector for the automatic control of the servomotor for synchronous motor starting rheostat, ammeters, voltmeters, frequency meter, Wattmeter and accessories.

d) No. 17 dust power distribution boxes, for 1000 V operating voltage composed of sealing sleeves, main isolating switch, 440/220 V transformer for auxiliary services complete with switches and fuses, copper bus-bars for main and auxiliary circuits, starting lines for motor feeding with remote motor protectors provided with power fuses, ammeter, push-button station and accessories.

e) 19 dust proof lighting distribution panels for 600 V operation, composed each of main automatic switch and automatic switches for branched circuits, complete with terminal boards and accessories.

f) Miscellaneous accessories for power system comprising:

—push-button dust proof stations for motor control.

—black enameled steel pipes, assorted sizes, suitable for electric connections, and cable protection in particularly exposed location, global weight 5,000 lbs.

—accessories for ditto.

—water tight distribution boxes of assorted sizes.

—leading-in bushes, insulating tape, sterling tape.

14-3—ELECTRIC MOTORS:

Pcs.	Machinery	No	HP	r.p.m.	Starting torque	Type
1-2	Crusher	1	450	975	1.5	Ksp
1-3	Belt conveyor	1	50	1460	1.5	Ksp
2-1	Clay wash mills	2	125	1470	1.5	Ksp
2-2	Centrifugal pumps ...	3	45	1460	1.5	Ksp
2-4	Centrifugal pumps ...	2	35	1460	1.5	Ksp
3-3	2.8 x 11.50 mill	1	1700	375	2.5	AS
3-3	Auxiliary drive	1	20	720	2.5	Ksp
4-1	Centrifugal pumps ...	2	45	1460	1.5	Ksp
4-2	Centrifugal pumps ...	2	45	1460	1.5	Ksp
4-3	Centrifugal pumps ...	2	40	1460	1.5	Ksp
5-2	Agitator sleving bridge motion	2	10	1440	1.5	Kgp
5-2	Agitator motion	2	12.5	1440	1.5	Ksp
5-3	Compressors	3	125	970	1.5	Ksp
5-6	Centrifugal pumps ...	2	15	1440	1.5	Kgp
6-2	Kiln	2	175/58	1000/330	2.5	
6-3	Grate drive	1	15	1440	1.5	Kgp
6-3	Chain drive	1	5	1430	1.5	Kgp
6-3	Blower drive	1	70	1470	1.0	Ksp
6-3	Blower drive	1	35	1460	1.0	Ksp
6-3	Crusher drive	2	10	1440	1.0	Kgp
6-5a)	Exhauster fan	1	200	975	1.0	Ksp

Pcs.	Machinery	No	HP	r.p.m.	Starting torque	Type
7-1	Bucket conveyor	1	20	1450	1.5	Ksp
9-1	Apron feeder	1	5	1430	1.5	Ksp
9-2	Impact crusher	1	60	1460	1.5	Ksp
9-3	Bucket elevator	1	15	1440	1.5	Kgp
9-4	Chain feeder	1	5	1430	1.5	Kgp
9-5	Belt conveyor	1	10	1440	1.5	Kgp
10-1	Chain feeder	1	3.5	1430	1.5	Ksp
10-2	Peters mill	1	160	1470	1.5	Ksp
10-3	Fan	1	170	1470	1.0	Ksp
12-2	3.20 x 10 mill	1	2250	375	2.5	AS
12-2	Auxiliary drive	1	25	720	2.5	Ksp
12-4	Elevators	2	40	1460	1.5	Ksp
12-6	Sturtevant	2	125	970	1.5	Ksp
12-8b)	Fan	1	60	970	1.0	Ksp
13-1	Apron feeder	1	5	1430	1.5	Kgp
13-2	Crusher	1	20	1450	1.5	Ksp
13-3	Bucket elevator	1	5	1430	1.5	Kgp
14-1a)	Fuller pump	1	90	730	1.5	Ksp
14-1b)	Compressor	1	130	730	1.5	Ksp
14-3b)	Compressor	2	20	960	1.5	Ksp
14-3c)	Compressor	1	30	1450	1.5	Ksp
14-5	Elevators	2	30	1450	1.5	Ksp
14-6b)	Fan	2	7.5	2850	1.0	Kgp
15-1	Vibrating screen	2	5	1430	1.5	Kgp
15-3	Bag packing machine .	4	25	960	1.5	Ksp
15-4	Filter blower	2	35	1460	1.0	Ksp
16-1	Belt conveyor	2	3	1430	1.5	Kgp
16-3	Belt conveyor	1	5	1430	1.5	Kgp
16-4	Belt conveyor	1	5	1430	1.5	Kgp
16-5	Belt conveyor	1	5	1430	1.5	Kgp
16-6	Belt conveyor	1	5	1430	1.5	Kgp
16-9	Belt conveyor	2	10	1440	1.5	Kgp
16.13	Dust recovery screw conveyor	2	3	1430	1.5	Kgp

All the above motors are of the asynchronous type, suitable for 400 V, 60 cycles feed, excepting the driving motors of the two mills, which shall be of the synchronous-asynchronous type, suitable for 6600 V, 60 cycles feed, thus to improve, without manual control, the value of the power factor up to the unity.

Type of motors

Kgp—Protected construction, internal self-ventilation with downward air inlets, cage rotor up to 20 HP and with double cage rotor for greater power output; horizontal shaft on dust-proof bearings.

Ksp—Protected self-ventilated construction, with downward air inlets with coil rotor and fixed or mobile brushes according to requirements, horizontal shaft on dust-proof ball bearings.

The above motors will be complete with closed oil bath starting rheostat, sized according to the starting torque.

AS — Open type construction, rotor with starter coil located on the pole shoes; horizontal shaft on dust proof automatic lubrication bearings.

Each synchronous-asynchronous motor will be complete with exciter, field and starting rheostat.

Equipment composed of:

a) One D.C. electric motor, closed type, forced ventilation through electric fan driven by independent driving motor, horizontal shaft, supports fitted with grease lubricated ball bearings, separate excitation shunted from the following exciter, copper slip rings of proper size, carbon brushes.

b) One converting unit consisting of three machines with horizontal shaft, duly coupled together by flexible couplings:

   i) D.C. generating dynamo, self-ventilated protected type, grease lubricated ball bearings, separate excitation shunted from the following exciter, copper slip rings of proper size, carbon brushes.

   ii) Three phase asynchronous electric motor, lateral ventilation, protected type, slip ring rotor, brush lifting and short circuit device.

   iii) Exciter suitable for exciting the D.C. motor and the main dynamo, ventilated protected type, ball bearings, compound excitation.

c) One switchboard provided with the required instruments for control and operation of the above machines, complete with the pertaining electric equipment.

15—ELECTRIC CABLES AND EARTHING MATERIALS:

15-1 Electric cables for power feed and lighting system, as well as the auxiliary circuits for signals and factory control as follows:

a) Soft copper cables, rubber insulated with polychloreprene outer lining suitable up to 1 kV operation.

Section	Length
0.002480 sq. in.	11,500 ft.
0.003875 sq. in.	11,500 ft.
0.003875 sq. in.	21,500 ft.
0.006200 sq. in.	8,500 ft.

b) Soft copper cables, impregnated paper insulation, outer lead protection armoured with iron tapes, jute covered, suitable up to 2 KV operation.

0.009765 sq. in.	26,500 ft.
0.01550 sq. in.	5,000 ft.
0.02480 sq. in.	5,000 ft.
0.03875 sq. in.	5,000 ft.
0.07750 sq. in.	5,250 ft.
0.11625 sq. in.	1,000 ft.
0.15500 sq. in.	1,650 ft.
0.19375 sq. in.	1,650 ft.
0.27900 sq. in.	6,600 ft.
0.37200 sq. in.	2,000 ft.

c) Soft copper cables as per pos. b, but suitable up to 10 kV operation.

0.24800 sq. in.	700 ft.

d) Accessories for cable erection work, cable underground junction boxes.

15-2 Earthing equipment consisting of No. 50 earth plates of galvanized steel sheet, earth terminal and cast iron covers for inspection and measure of earth resistance; 3,300 lbs. of copper wire 9/32" and 3/16" dia., biprene insulated for earthing the motors and the electric equipment.

—Miscellaneous accessories:

16—GEAR BOXES:

Pos.	Machinery	No	HP	Speed ratio r.p.m.
1-3	Belt conveyor	1	50	1460/25
2-1	Clay wash mill	2	125	735/97
3-3	Mill main drive	1	1700	375/165
3-3	Mill auxiliary drive	1	20	720/3.7
5-2	82 ft. dia. basin agitator	2	10	1440/27
5-2	82 ft. dia. basin agitator	2	12.5	1440/27
6-2	Kiln main drive	2	175	900/6
6-2	Kiln auxiliary drive	2	50	1500/85
9-3	Elevator	1	12.5	1440/40
9-5	Belt conveyor	1	10	1440/40
12-2	Mill main drive	1	2250	375/165
12-2	Mill auxiliary drive	1	25	720/3.7
12-4	Elevators	2	40	1450/90
13-3	Elevator	1	3	1430/40
14-5	Elevators	2	30	1450/40
16-1	Belt conveyor	2	3	1430/40
16-3	Belt conveyor	1	5	1430/40
16-4	Belt conveyor	1	5	1430/40
16-5	Belt conveyor	1	5	1430/40
16-6	Belt conveyor	1	5	1430/40
16-9	Belt conveyor	2	10	1440/40
16-13a)	Screw conveyor	2	3	1430/60

NOTE:

All RPMs are for 50-cycle current. In order to get the correct RPM for 60-cycle current multiply given RPM figures by 1.2 and round off to the nearest 10 RPM.

17—LABORATORY EQUIPMENT:

17-1 A line of apparatus and accessories for running technological cement tests, covering: a set of sieves; a Vicat needle with two thermometers; a Le Chantelier apparatus; a Sebuman volumenometer; a revolving basin mixer and rotating compression grinding wheel; a set of stirrups for preparation of test pieces; a universal Klebe-type hammer device for preparation of test pieces; a 200 t hydraulic press for compression tests with control copper test pieces and calibration box; a double lever weighing machine for tensile tests with accessories; a deflectometer; a Dietrich-Frulling calcimeter.

17-2 A line of apparatus and accessories for carrying out chemical examination of raw materials and cement clinker, comprising: three precision balances with boxes of weights; a still of the gasoline heating type; a Mahler calorimeter for liquid fuel; an electric drying oven, an Orsat apparatus; two Kipp apparatus; two Fruhlige Schultz dryers; a set of stands for burettes, and test tubes, bottles, burettes, porcelain evaporating dishes, flasks, crucibles, etc.

Note-The final complete equipment list should be determined in accordance with the recommendations of the chief chemist in the technical staff which will prepare the final specifications.

INDICATION OF PERFORMANCE AND CONSUMPTION DATA:

(Approximate and not binding)

1. **Limestone crusher**

The hammer crusher described under pos. 1-2 will be capable of crushing 250 metric tons/hour of limestone coming in splits of 32" x 32" x 32" into splits of 7/8" at an average power consumption of 0.8 kWh per crushed ton of limestone.

2. **Raw material grinding unit.**

The unit described under pos. 3-1 to 3-3 will be capable of grinding 70 metric tons/hour of raw material into a fineness corresponding to the residue of 5-7% on the 170 meshes sifter. The power consumption will be 18 kWh per ground ton of raw material, supposing maximum size of 7/8" when delivered to mill inlet. Water contents of ground slurry 35-42%.

3. **Burning Unit**

The rotary kiln shall yield in 24 hours of continuous service 750 metric tons of normal Portland cement clinker under a heat consumption of 2,340 BTU/lb. of clinker.

This value will be obtained by bunker oil "C" with a net heat value of 18,000 BTU/lb. and supposing that the water contents in the slurry raw material is 35%.

The energy consumption of the burning unit will be 12 KWh per ton of clinker.

4. **Gypsum crusher**

The impact crusher described under pos. 13-2 will be capable of crushing 10 metric tons/hour of gypsum coming in splits of 12" x 16" x 12" into splits of 3/4" at an average power consumption of 1 kWh per crushed ton of bunker oil "C".

5. Cement grinding unit

The grinding unit described under Pos. 12-1 to 12-8 shall be capable of an output of 50 metric tons/hour of cement with a fineness corresponding to the residue of 2-3% on the sifter having 170 meshes with a specific consumption of 39 kWh per ton of product.

The same grinding unit shall be capable of an output of 42 metric tons/hour of cement with a fineness corresponding to the residue of 1-1.5% on the sifter having 170 meshes with a specific energy consumption of 46.5 kWh per ton of product.

6. Overall heat consumption

The overall heat consumption of the cement plant machinery, will be 2,340 BTU/lb. of clinker, supposing the slurry having water contents of 35%, firing bunker oil "C" having a net heat value of 18,000 BTU/lb.

7. Overall power consumption

The overall power consumption of the cement plant machinery will be 98 kWh per ton of cement ground into a fineness corresponding to the residue of 2-3% on the sifter having 170 meshes less crane for hangar, cement bag conveyors and any other services.

STORAGE BUILDING DIMENSIONS:

Assuming the use of an electric travelling crane with a span of 30 meters or 100 feet, and a lift of 20 meters, and assuming further that 80% of this lift will be filled up with materials, the material storage therefore, will have a storing capacity of 30 x 20 x 0.8 = 480 cubic meters per meter of storage building length. Since the raw material requirement of the plant as stated before, is 1,250 MT per day, or 37,500 MT per month which is equivalent to 25,000 cubic meters based on the specific gravity of about 1.5 for loose limestone, it may be readily seen that this amount of limestone will need a storage building length of about 50 meters. A building space of the same length will be capable of storing the output of the kiln for 50 days, so that a 100-meter length would be able to store 100 days' production of the kiln. Adding 10 meters for gypsum and corrective raw materials, we get a total length of 160 meters. The dimensions of the storage building, therefore, may be about 160 meters long x 30 meters wide x 20 meters vertical length of the travelling crane. This is approximately equivalent of 525' x 100' x 66' storage space for a building to store 30 days' raw materials and 100 days' clinker output. These dimensions, however, may be varied according to the agreed amounts of raw materials and clinker to be stored.

(c) Supplies and Spares:

The following are the essential supplies and spares which have to be provided and kept in stock for the maintenance and operation of the plant:

1—GRINDING MEDIA

1-1 One set of grinding media for raw mill item 3-3, consisting of steel balls of different diameters from 2" to 4" and steel cylpebs, inclusive of 25% spare.

1-2 One set of grinding media for cement mill item 9-2, consisting of steel balls of different diameters from 4" to 2" and hardened steel cylpebs, inclusive of 25% spare.

2—REFRACTORIES AND INSULATION FIREBRICKS

(Plus 25% spare)

Section	Description	Quality	Weight lbs.
	Rotary kiln		
2-1	Firing hood	42% Al_2O_3	82,390
	Refractory cement for ditto 5%	42% Al_2O_3	4,246
2-2	Sintering zone	70% Al_2O_3	363,000
	Refractory cement for ditto 5%	70% Al_2O_3	18,150
2-3	Discharge zone and presintering	42% Al_2O_3	629,200
	Refractory cement for ditto 5%	42% Al_2O_3	31,460
2-4	Calcification zone and drying end	33% Al_2O_3	459,800
	Refractory cement for ditto 5%	33% Al_2O_3	23,100
2-5	Drying zone	28% Al_2O_3	440,000
	Refractory cement for ditto 5%	28% Al_2O_3	21,780

Section	Description	Quality	Weight lbs.
	Rotary kiln		
2-6	Insulating bricks	—	132,000
	Refractory cement for ditto 5%	—	6,600
2-7	Bricks for dust chamber ducts and chimney	—	48,400
	Refractory cement for ditto	—	9,680
	Fuller grate		
2-8	Suspended ceiling	42% Al_2O_3	47,300
	Refractory cement for ditto 5%	42% Al_2O_3	2,420
2-9	Side walk brickwork	28% Al_2O_3	300,400
	Refractory cement for ditto 5%	28% Al_2O_3	14,520
			1,192,930

(d) **Other requirements:**

1. **Gypsum:**

At a maximum of 4% gypsum requirement in the finished cement, the annual requirement for this commodity would be 750 x .04 x 300 = 9,000 MT.

2. **Bunker "C" fuel:**

At the usual 2,500 BTU requirement per pound of cement produced by the wet process, the total daily fuel requirement will be $\frac{2,500 \times 94 \times 18,000}{18,000 \times 2,000} = 117.5$ or say 120 short tons per day or 36,000 tons of 2,000 lbs. per year.

3. **Water:**

At the usual requirement of 1 lb. of water for every pound of cement in the wet process, the water requirement will be $\frac{750 \times 2,200}{8.33 \times 24 \times 60} = 137.5$ or say 150 GPM. If the river pump which will supply water to a reservoir tank near the plant is made to work for only 8 hours per day or 1/3 of the time, and 50% is added for other non-potable water requirements, the river pump capacity, therefore, has to be 150 x 3 x 1.5 = 675, or say 700 GPM exclusive of the discharge equivalent of the friction losses of the approximately 1-km. long pipe between the pump and the reservoir.

4. **Electric Power:**

The common accepted standard for energy requirement in a wet process cement plant is usually placed at 100 kWh per MT. of cement produced. With this as the basis, it follows that the basic power requirement of this plant is $\frac{100 \times 750}{24} = 3.125$ kW. If we assume temporary overloadings of the plant to as much as 10%, with the load factor at 80%, the total plant power requirement would then be $\frac{3.125 \times 1.1}{0.8} = 4{,}300$ kW. Allowing 200 kW. for lighting and other small power requirements, the total peak power should be 4,500 kW. or almost 6,000 KVA at 80% power factor. This seems to agree with a rule of the thumb developed from the personal experiences of the men composing the survey team, that peak power requirement should be equal to the plant daily production in barrels. The average power demand should be about 4,000 kW. It is believed that this plant should be provided with a 7,000 KVA main substation.

PART V

FINANCIAL REQUIREMENTS:

(a). Cost of Real Estate and Mineral Rights:

The present market values of real state within and around the mineral claims mentioned in Part III of this project study range from P0.20 to P1.00 per square meter, depending upon the quantity and quality of the coconuts available from the areas concerned, and their proximity to the national highway. The cost of acquiring the lease contract from the government covering the mineral claims mentioned in Part III will be the total of the cost of sampling and surveying including core drilling and all laboratory works involved. If the recommendation of the survey team to acquire the title to 100 hectares of these claims including the plant site is followed, the necessary outlay for the purpose will be anywhere between P200,000.00 and P1,000,000.00.

(b). Total Cost of Installed Plant:

An estimate of the total cost of this installed plant may be broken down as given below:

ESTIMATED COST OF INSTALLED PLANT

1. Main Plant equipment	$ 3,500,000.00	4,200,000.00
2. Quarry, Shops and Laboratory	1,000,000.00	1,200,000.00
3. Spares, Grinding media & Firebricks	500,000.00	600,000.00
4. Total Imports	$ 5,000,000.00	6,000,000.00
5. Total Imports in pesos	P19,562,500.00	23,475,000.00
6. Engineering, Construction and Erection	6,800,000.00	7,480,000.00
7. Misc. Expenses & Taxes	3,700,000.00	4,070,000.00
8. Estimated cost of Plant Installation	P30,062,500.00	35,025,000.00

The current exchange rate of P3.9125 per $ has been used throughout. It may be noted that the second column is obtained by the addition of contingent amounts equivalent to 20% on the $ cost and 10% on the P cost.

Further breakdown of item No. 6 for Engineering, Construction, and Erection may be given as follows:

ROUGH ESTIMATE OF THE PLANT

CONSTRUCTION AND ERECTION:

Cost of Foundations and Buildings:

Building No. 1	Electrical Substation	P 50,000.00
" " 2	Crusher	200,000.00
" " 3	Storage	1,800,000.00
" " 4	Raw & Finish Mill	1,000,000.00
" " 5	Slurry Storage	450,000.00
" " 6	Kiln and Cooler	600,000.00
" " 7	Cement Silos	500,000.00
" " 8	Pack House	200,000.00
Total Cost of Industrial Buildings		P4,800,000.00
Building Nos. 9, 10, 11, & 12 (Shops, Office, Laboratory) and Guest House)		300,000.00
Filling and Grading		200,000.00
Equipment Erection		1,200,000.00
Estimated total cost of **Const. & Erection**		P6,500,000.00
Cost of Engineering		300,000.00
Total Cost Exclusive of Contingency		P6,800,000.00

The above estimate shows that the total cost of the installed plant is expected to be within the range of P30,062,500.00 to P35,025,000.00. An American construction firm has offered to erect the plant complete and ready for operation in accordance with mutually agreed plans and specifications for the price of $8,750,000.00. At the current rate of P3.9125 this amount would be equivalent to P34,234,375.00. Based on our estimate above, this American firm would stand to reap a profit of P4,171,875.00 if our lower estimate will come true, or lose P780,625.00 if the higher estimate will hold true. As a part of the contract, this American contractors will take care of securing a loan in the amount of 80% of the agreed cost of the plant, which loan in this case, will be $7,000,000.00. This loan will be payable in equal semi-annual amortization annuities for a period of 15 years, at the annual interest of 7½%. The same contractors will subscribe to the balance of 20% in the maximum amount allowed by the laws of the Philippines. This means that the project will become a joint Filipino-American venture with the Filipino capital in the majority. The required owner's equity will be $1,750,000.00 or P6,846,875.00 at the current rate of P3.9125 per dollar, exclusive of the necessary initial operat-

ing capital which should be equivalent to, at least, one-fourth of the estimated annual operating expenditures.

(c). Initial Operating Capital and Total Local Capital Requirements:

A breakdown of the required annual operating capital for the project plant is shown in Tables F-20 and F-22. Tables F-20 and F-21 were prepared for the purpose of comparison with the corresponding Tables F-10 and F-11 for the dry process. The only difference between Table F-21 and Table F-22 is the 10% interest on local capital. While Table F-21 includes only the interest on the local counterpart of the fixed capital investment, Table F-22 includes the interest on the additional capital requirement for the initial operating capital and the costs of the plant sites and mineral rights which together with the local counterpart of the fixed capital form the required authorized capital of the cement corporation as shown in Table F-23. Both Tables F-22 and F-23 clearly show the following:

1. The required minimum initial operating capital for the first quarter of operation which amounts to about P2,000,000.00.
2. The required authorized capital of the cement corporation which should be set at P10,000,000.00.
3. The total annual operating cost of the plant which amounts to almost P13,000,000.00.

It should be noticed that the financing cost set forth in these tables includes not only the annual amortization on the foreign loan but also the annual interest on the local counterpart. If we assume the actual sale from the plant to the marketing organization to be at P2.70 per bag of 94 lbs., the profit before taxes for the annual production of 5,400,000 bags would be as follows:

a. Total sales	P14,580,000.00
b. Cost of production	12,949,712.50
c. Profit before taxes	P1,630,287.50

This means a profit of about P0.30 per bag or 16.3% of the local capital investment. The marketing organization may make its own profit from the cost of P2.70 to the "pre-shortage" normal price of P3.40 or to the present prevailing prices throughout the country which range from P4.80 to P6.00 per bag. The transportation cost averages approximately P0.10 per 100 miles per bag for both land and water routes, while handling costs for both ends is usually about P0.05 per bag.

TABLE F—10

COSTS BREAKDOWN IN DRY PROCESS

Item	Requirement per MT. of Finished Cement	Unit Cost	Cost per MT. of Cement	Cost per bag of Cement	Annual Total
Fuel oil (18,000 BTU/ lb.) for Kiln	242 lbs.	₱70.00/2000 lbs.	₱ 8.47	₱0.353	₱1,905,750.00
Electricity for Process	120 Kwh	₱ 0.0125/Kwh	1.50	0.063	416,416.67
Electricity for other uses	28 Kwh	₱ 0.0125/Kwh	0.35	0.015	
Labor	4.0 Man-hrs.	₱ 0.90/M-hr.	3.60	0.150	803,675.67
Water	222 gals.	₱ 0.10/1000 g.	0.02	0.001	4,995.00
Limestone & Shale	1.6 MT.	₱ 2.00/MT.	3.20	0.133	720,000.00
Gypsum	0.03 MT.	₱50.00/MT.	1.50	0.063	337,500.00
Refractories	1.6 lbs.	₱ 0.30/lb.	0.48	0.020	108,000.00
Lubricants	4.5 oz.	₱ 0.60/lb.	0.17	0.007	37,968.75
Grinding Media	2.8 lbs.	₱600.00/MT.	0.76	0.032	171,818.18
Spare Parts	3.1 lbs.	₱ 1.25/lb.	3.88	0.161	968,750.00
Manufacturing Expenses for loose Cement			23.93	0.998	₱5,474,874.27
Bag 4 ply	24 pcs.	₱ 0.30/bag	7.20	0.300	1,620,000.00
Manufacturing Expenses for Packed Cement			31.13	1.298	₱7,094,874.27

TABLE F—II

COSTS BREAKDOWN IN DRY PROCESS

Item	Cost per MT of Cement	Cost per bag of Cement	Annual Total
Manufacturing Expenses for Packed Cement	₱ 31.13	₱ 1.298	₱7,094,874.27
Annual Straight Depreciation:			
$5,000,000.00 for 15 yrs. @ $1.00 — ₱3.9125.	5.80	0.242	1,304,166.67
Uniform Annual (0.0591/1.00) Amortization @ 7½% p. a. for 15 years on $7,400,000.00 foreign loan.	14.44	0.602	3,248,470.50
Interest of 10% p. a. on ₱7,238,125.00 local fixed capital.	3.22	0.134	723,812.50
Prime Cost of Packed Cement ex-plant.	54.59	2.276	₱12,371,323.94
Overhead Expenses	2.00	0.083	450,000.00
Total Cost of Packed Cement ex-Plant.	56.59	2.359	₱12,821,323.94

TABLE F—20

COSTS BREAKDOWN IN WET PROCESS

Item	Requirement per MT. of Finished Cement	Unit Cost	Cost per MT. of Cement	Cost per bag of Cement	Annual Total
Fuel oil (18,000 BTU/lb.) for Kiln	298 lbs.	₱70.00/2000 lbs.	₱10.43	₱0.435	₱2,346,750.00
Electricity for Process	100 Kwh	₱0.0125/kwh	1.25	0.052	360,000.00
Electricity for other uses	28 Kwh	₱0.0125/kwh	0.35	0.015	
Labor	3.7 Man-hrs.	₱0.90/Man-hrs.	3.33	0.139	743,400.00
Water	376 gals.	₱0.10/1000 gals.	0.04	0.002	8,460.00
Limestone & Shale	1.6 MT.	₱2.00/MT.	3.20	0.133	720,000.00
Gypsum	0.03 MT.	₱50.00/MT.	1.50	0.063	337,500.00
Refractories	1.6 lbs.	₱0.30/lb.	0.48	0.020	108,000.00
Lubricants	4 oz.	₱0.60/lb.	0.15	0.006	33,750.00
Grinding Media	2.6 lbs.	₱600.00/MT.	7.71	0.030	159,600.00
Spare Parts	2.9 lbs.	₱1.25/lb.	3.63	0.151	815,625.00
Manufacturing Expenses for loose cement			25.07	1.046	₱5,633,085.00
Bag, 4 ply	24 pcs.	₱0.30/bag	7.20	0.300	1,620,000.00
Manufacturing Expenses for Packed cement			32.27	1.346	₱7,253,085.00

TABLE F — 21

COSTS BREAKDOWN IN WET PROCESS

Item	Cost per MT. of Cement	Cost per Bag of Cement	Annual Total
Manufacturing Expenses for Packed Cement	₱32.27	₱ 1.346	₱7,253,085.00
Annual Straight Depreciation:			
$4,500,000.00 for 15 years @ $1.00 = ₱3.9125.	5.22	0.217	1,173,750.00
Uniform Annual Amortization on $7,000,000.00 Foreign loan per payment schedule.	13.66	0.569	3,072,877.50
Interest of 10% p.a. on ₱6,846,875.00 local fixed capital	3.04	0.127	684,687.50
Prime Cost of Packed Cement ex-Plant	54.19	2.259	₱12,184,399.50
Overhead Expenses	2.00	0.083	450,000.00
Total Cost of Packed Cement ex-Plant	56.19	2.342	₱12,634,399.50

TABLE F — 22

COSTS BREAKDOWN IN WET PROCESS

Item	Cost per MT. of Cement	Cost per Bag of Cement	Annual Total
Manufacturing Expenses for Packed Cement	₱ 32.27	₱ 1.346	₱7,253,085.00
Straight Annual Depreciation on $4,500,000.00 for 15 years @ $1.00 = ₱3.9125.	5.22	0.217	1,173,750.00
Uniform Annual Amortization on $7,000,000.00 Foreign Loan per Payment Schedule.	13.66	0.569	3,072,877.50
Interest of 10% on ₱10,000,000.00 for Mineral and Plant sites, local fixed Capital counterpart, and initial operating Capital	4.44	0.187	1,000,000.00
Prime Cost of Packed Cement ex-Plant	55.59	2.319	12,499,712.50
Overhead Expenses	2.00	0.083	450,000.00
Total Cost of Packed Cement ex-Plant	57.59	2.402	12,949,712.50

TABLE F — 23

SUMMARY OF ESTIMATED MINIMUM LOCAL FINANCING

Manufacturing Cost of Packed Cement	P 7,253,085.00
Overhead Expenses	450,000.00
Annual Operating Capital excluding Year-end Outlays for Depreciation, Amortization, and Local Financing Costs	7,703,085.00
Minimum Initial Operating Capital for 1st Quarter (1/4 of P7,703,085.00)	P 1,925,771.00
Local Counterpart of Fixed Capital ($1,750,000.00 x 3.9125)	6,846,875.00
Cost of Plant Site and Mineral Rights	500,000.00
Total Local Capital Requirement	P 9,272,646.00
Required Authorized Capital of Cement Corporation	P10,000,000.00

TABLE F — 30

PAYMENT SCHEDULE OF SEMI-ANNUAL AMORTIZATION PAYMENTS ON $7,000,000.00 FOR 15 YEARS AT 7½% COMMENCING 12 MONTHS AFTER START OF NORMAL COMMERCIAL PRODUCTION

Yr.	Interest	Payment on Principal	Total Payment	Approximate Uniform Amortization 0.0561/1.00
1.	$262,500.00	$233,333.33	$495,833.33	$392,700.00
2.	253,750.00	"	487,083.33	"
3.	245,000.00	"	478,333.33	"
4.	236,250.00	"	469,583.33	"
5.	227,500.00	"	460,833.33	"
6.	218,750.00	"	452,083.33	"
7.	210,000.00	"	443,333.33	"
8.	201,250.00	"	434,583.33	"
9.	192,500.00	"	425,833.33	"
10.	183,750.00	"	417,083.33	"
11.	175,000.00	"	408,333.33	"
12.	166,250.00	"	399,583,33	"
13.	157,500.00	"	390,833.33	"
14.	148,750.00	"	382,083.33	"
15.	140,000.00	"	373,333.33	"
16.	131,250.00	"	364,583.33	"
17.	122,500.00	"	355,833.33	"
18.	113,750.00	"	347,083.33	"
19.	105,000.00	"	338,333.33	"
20.	96,250.00	"	329,583,33	"
21.	87,500.00	"	320,833.33	"
22.	78,750.00	"	312,083.33	"
23.	70,000.00	"	303,333.33	"
24.	61,250.00	"	294,583.33	"
25.	52,500.00	"	285,833.33	"
26.	43,750.00	"	277,083.33	"
27.	35,000.00	"	268,333.33	"
28.	26,250.00	"	259,583.33	"
29.	17,500.00	"	250,833.33	"
30.	8,750.00	"	242,083.33	"
	Total	P7,000,000.00	$11,068,750.00	$11,781,000.00

TABLE F — 40

PLANTILLA OF PERSONNEL

A. Corporate Office:

- 1 Chairman of the Board
- 1 President & General Manager
- 1 Treasurer
- 1 Secretary of the Board
- 1 Comptroller

	Minimum Starting Monthly Rates
B. Central Office:	
1 Executive Assistant	960.00
1 Secretary	240.00
1 Administrative Secretary	480.00
1 Property Clerk (Clerk 2/c)	170.00
1 Steno-Typist (Clerk 3/c)	120.00
1 File Clerk-Typist (Clerk 3/c)	120.00
1 Purchasing Agent	340.00
2 Clerk-Typists (Clerk 3/c) @120	240.00
1 Draftsman (Clerk 3/c)	120.00
2 Janitor-Messenger @120	240.00
1 Chief Accountant	680.00
2 Accounting Clerks (Clerk 2/c) @170	340.00
1 Cashier (Clerk 1/c)	340.00
Total salaries & wages of the Manila Central Office	4,390.00
C. Production Division:	
I. Office of the Production Manager:	
1 Production Manager	1,500.00
1 Secretary-Receptionist (Clerk 1/c)	240.00
II. Administrative Department:	
1 Plant Office Chief	680.00
1 Secretary (Clerk 2/c)	170.00
(1) Administrative Section:	
1 Administrative Assistant	480.00
1 Timekeeper (Clerk 1/c)	240.00
1 Time Clerk (Clerk 3/c)	120.00

1 Paymaster (Clerk 1/c)	240.00
1 Pay Clerk (Clerk 3/c)	120.00
2 Drivers (Operators 3/c) @120	240.00
1 Messenger-Janitor (Laborer)	120.00
1 Gardener (Laborer)	120.00
1 Guest House Caretaker-Cook (Laborer)	120.00

(2) Personnel Section:

1 Personnel Assistant	340.00
1 Personnel Clerk (Clerk 2/c)	170.00

(3) Accounting Section:

1 Plant Accountant	480.00
1 Cost Accountant (Clerk 1/c)	240.00
1 General Bookkeeper (Clerk 1/c)	240.00
1 Accounting Clerk (Clerk 2/c)	170.00

(4) Receiving-Shipping Section:

1 Receiving-Shipping Supervisor	480.00
1 Stock Clerk (Clerk 1/c)	240.00
1 Receiving Clerk (Clerk 2/c)	170.00
4 Shift Issue Clerks (Clerks 3/c) @120	480.00
1 Shipping Clerk (Clerk 2/c)	170.00
1 Checker (Clerk 3/c)	120.00
4 Baggers (Laborers) @120	480.00

(5) Clinic Section:

1 Physician (Part Time)	300.00
1 Dentist "	200.00
1 Nurse (Lab. Helper 1/c)	240.00
4 Shift Attendants (Lab. Helpers 3/c) @120	480.00

III. Chemical Department:

1 Chief Chemist	960.00
1 Secretary (Clerk 2/c)	170.00

(a) Testing and Research Section:

1 Analytical Chemist	680.00
1 Physical Tester	340.00
1 Laboratory Helper 2/c	170.00

(b) Quality Control Section:	
4 Control Chemists @480	1,920.00
4 Laboratory Helpers 1/c @240	960.00
4 Laboratory Helpers 3/c @120	480.00
IV. Operation Department:	
1 Chief Engineer	960.00
1 Secretary (Clerk 2/c)	170.00
(a) Maintenance Sub-Department:	
1 Maintenance Engineer	680.00
(1) Engineering and Research Section:	
1 Electrical Engineer	680.00
1 Civil Engineer	480.00
1 Mining Engineer	480.00
1 Mechanical Engineer	340.00
1 Chemical Engineer	340.00
1 Surveyor (Clerk 1/c)	240.00
1 C.E. Draftsman (Clerk 2/c)	170.00
1 M.E. Draftsman (Clerk 2/c)	170.00
1 E.E. Draftsman (Clerk 2/c)	170.00
(2) Shop Section:	
1 Shop Foreman	480.00
1 Head Mechanic (Mech. 1/c)	240.00
4 Shift Mechanics (Mech. 2/c) @170	680.00
2 Day Mechanics (Mech. 3/c) @120	240.00
2 Welders (Mech. 2/c) @170	340.00
1 Diesel Mechanic (Mech. 2/c)	170.00
1 Auto Mechanic (Mech. 3/c)	120.00
1 Head Machinist (Mach. 1/c)	240.00
2 Machinists 2/c @170	340.00
1 Head Electrician (Elect. 1/c)	240.00
4 Shift Electricians (Elect. 2/c) @170	680.00
1 Rewinder (Elect. 2/c)	170.00
1 Asst. Rewinder (Elect. 3/c)	120.00
1 Mason 1/c	240.00
1 Mason 2/c	170.00
1 Blacksmith 1/c	240.00
1 Blacksmith 3/c	120.00
1 Carpenter 1/c	240.00
1 Carpenter 3/c	120.00

(3) Yard Section:

1 Yard Foreman	340.00
1 Crane Operator (Opr. 2/c)	170.00
1 Asst. Crane Operator (Opr. 3/c)	120.00
2 Riggers (Laborer) @120	
Casual Laborers @4.00/day	240.00

(b) Mill Sub-Department:

4 Mill Engineers @480	1,920.00

(1) Quarry-Crusher Section:

1 Quarry-Crusher Foreman	340.00
1 Head Quarryman (Opr. 1/c)	240.00
1 Blaster (Opr. 2/c)	170.00
1 Asst. Blaster (Opr. 3/c)	120.00
1 Driller (Opr. 2/c)	170.00
1 Asst. Driller (Opr. 3/c)	120.00
1 Lime Shovel Operator (Opr. 2/c)	170.00
1 Asst. Lime Shovel Operator (Opr. 3/c)	120.00
1 Crane Operator (Opr. 2/c)	170.00
1 Asst. Crane Operator (Opr. 3/c)	120.00
1 Bulldozer Operator (Opr. 2/c)	170.00
4 Truck Drivers (Opr. 3/c) @120	480.00
1 Shale Shovel Operator (Opr. 2/c)	170.00
1 Asst. Shale Shovel Operator (Opr. 3/c)	120.00
1 Crusher Operator (Opr. 2/c)	170.00
1 Asst. Crusher Operator (Opr. 3/c)	120.00

(2) Raw End Section:

4 Mill Foremen @340	1,360.00
4 Millers (Opr. 2/c) @170	680.00
4 Asst. Millers (Opr. 3/c) @120	480.00
4 Blenders (Opr. 2/c) @170	680.00
4 Asst. Blenders (Opr. 3/c) @120	480.00
4 Cranemen (Opr. 2/c) @170	680.00
4 Asst. Cranemen (Opr. 3/c) @120	480.00

(3) Finish End Section:

4 Mill Foremen @340	1,360.00
4 Head Burners (Opr. 1/c) @240	960.00
4 Burners (Opr. 2/c) @170	680.00
4 Asst. Burners (Opr. 3/c) @120	480.00

4 Millers (Opr. 2/c) @170	680.00
4 Asst. Millers (Opr. 3/c) @120	480.00
4 Cranemen (Opr. 2/c) @170	680.00
4 Asst. Cranemen (Opr. 3/c) @120	480.00
Total Salaries & Wages of Plant Personnel	41,300.00

D. Marketing Division:

I. Division Office:

1 Marketing Manager	1,500.00
1 Secretary	240.00

II. Sales Promotion Department:

1 Sales Promoter	680.00
Sales Promotion Staff	

III. Sales Department:

1 Sales Superintendent	960.00
Sales Staff	

IV. Traffic Department:

1 Traffic Superintendent	960.00
Distribution & Transportation Staff	

(d) Comparative Economic Study Of The Dry vs. The Wet Process:

A comparison between Table F-10 vs. Table F-20 and Table F-11 vs. Table F-21 shows that the dry process uses about P0.082 worth of bunker fuel per bag less than the wet process. This advantage, however, is largely upset by the fact that the dry process plant requires about $500,000.00 more for its equipment than the wet process plant. This means more depreciation, more amortization, and more interest on local capital, since the total cost of the dry process plant would amount to $9,250,000.00 instead of the $8,750,000.00 for the wet process plant. The combined effect of these 3 items is to raise the cost of the bag of cement in the dry process by about P0.065. The other items are also higher for the dry process than the wet by P0.034 so that the total advantage of the wet process over the dry is about P0.099 or a net advantage of about P0.017 for the wet process over the dry.

This comparison was conducted by Fried Krupp of Germany based on raw materials for both processes having composite moisture contents of about 10%. Of course, raw materials having moisture contents above 10% would only make the advantage of the wet process even more pronounced. Since the average moisture contents of composite cement raw materials in Northern Mindanao have been observed to be within the range of 12 to 18%, it is, therefore, very clear that the choice between the two processes must be in favor of the wet process. On top of this economic advantage should be added the definite advantage of the wet process in the way of quality control which is admittedly much simpler than that of the dry process.

A report on an extensive study conducted by cement technologists of the F. L. Smidth & Company of Copenhagen, Denmark, on plants installed in India is hereunder quoted for all it may be worth to the reader:

"Comparison between various Kiln Types Dalmiapuram Extension"

"The comparison is made between kilns of rated capacity 500 Mt/-day. In the case of Dalmiapuram the figures relating to the following kiln types may be of interest:

a. Wet Process: Long kiln (length about 40 times diameter) with full set of internal fittings (slurry preheater, chains, and crosses) and cooler.

b. Dry Process: Long kiln (length about 40 times diameter) with crosses and cooler.

c. Dry Process: Short kiln (length 10-15 times diameter) with cyclone preheater and cooler.

These 3 types compare as shown in the attached statement.

The standing costs of the dry plant are higher than that of the wet plant on account of the higher capital outlay for raw drying, grinding and homogenizing equipment.

The run factors (indicating percentage running hours to total hours) have been based on actual figures from a great number of plants, and they represent average conditions. Individual plants may show much better figures; we know, for instance, of a wet-process kiln in Europe that worked for 756 days without interruption.

The figures for heat consumption are based on information from actual running plants, and the same applies to those for power consumption and dust loss.

We have assumed a price of 40 Rs./ton for coal with 6000 kcals/kg. and a power price of 0.04 Rs./unit. We believe these figures are approximately correct for Dalmiapuram. The coal price, although high compared to coal prices in certain other parts of India, is low compared to fuel prices in other parts of the world. The cost of raw meal or slurry is taken at 3.5 per ton clinker, and its percent dust loss is thus equivalent to 0.035 Rs./ton.

Comparing the two dry kiln types, the repair cost is lower for the long unit kiln than for the short kiln with preheater, the life of the lining in the burning zone being considerably shorter in the latter type of kiln than in the long unit kiln. The repair cost is somewhat higher for the wet kiln on account of maintenance to chains etc. installed in this type of kiln.

As regards departments other than the kiln department, the running costs are higher for the dry than for the wet plant. Although dry grinding consumes less grinding media and lining plates than wet grinding, the saving herefrom is more than offset by the higher power consumption, the extra fuel required for drying purposes, and the higher maintenance of the drying, grinding, and homogenizing departments.

The kiln with cyclone preheater requires additional staff for attending to the preheater, hence the higher wages.

The final result is that the total annual running and standing costs are Rs. 3,000,000 higher for the long dry kiln than for the long wet kiln. For the short kiln with cyclone preheater they are even Rs. 3,600,000 higher than for the long wet kiln.

Under favorable marketing conditions a forcing of the kiln may prove very advantageous, and in this connection it should be noted that the forcing limit is lower for dry process than for the wet process plants. In the shorter kiln with preheater it may be difficult to finish-burn the clinker at larger productions than the normal, and moreover the auxiliary machinery, particularly the fans, may set the limit of the production capacity. For the two types of dry kilns the forcing limits may be taken as 10%, corresponding to maximum annual outputs of 186,000 and 178,000 tons, respectively.

For the wet-process kiln the forcing limit may be taken as 20% when the slurry preheater is removed, corresponding to a maximum annual output of 195,000 tons. Again, this is an average figure, and we know of a wet kiln in Europe with a rated output of 500 Mt. that is regularly producing 670 metric tons with the slurry preheater in position.

The assumption in the above comparison are based on comprehensive material from many plants. As regards fuel and power cost, the actual figures for Dalmiapuram have taken into account, so far as they are known. Any modification in the basic assumptions will naturally cause a corresponding change in the result. Local conditions, mainly fuel and power cost, may cause preference to be given to the wet or dry process as the case may be, but very substantial modifications must be made in the assumption before the long economical kilns for the wet process, respectively, lose the leading position they have gained on the basis of general considerations regarding the aggregate economy of the plant.

Moreover, there are several factors that cannot directly be included in the economic considerations. The greatest importance must be attached to obtaining a uniform high quality of the clinker produced, and this is best achieved by the use of long kilns. Of all the phases of the manufacturing process the clinker burning exerts the greatest influence on the quality. At works with long kilns the burner is the most important of the operators, and the operation control is concentrated on governing the conditions in the burning zone. All the forms of operation with short kilns involve moving the center of gravity of the operational control from the burning zone to the inlet end of the kiln. With these kiln types the burner has to work on the conditions offered him by the installation at the inlet end, and any step he takes to regulate the burning gives complications in the inlet end with ensuing difficulties to himself. Out of deference to the clinker quality and the aggregate economy of the plant, the two long kiln types for wet and dry process, respectively, must be preferred to all other known types of kilns."

COMPARISON BETWEEN KILN TYPES
(Wet-Process Plant used as Basis)

		Wet		Dry
		a long kiln w. fittings	b long kiln w. fittings	c short kiln cycl. preh
Machinery and building cost for kiln dept.	Lakh Rs.	48	52	52
Depreciation and interest hereon	Lakh Rs.	5.4	5.8	5.8
Add for other standing cost	”	34.5	38.0	38.0
Total Standing costs	”	39.9	43.8	43.8
Run factor	%	90	94	90
Rated output	1000 ts/year	162	169	162
Heat consumption A	cals/kg.	1350	1050	1000
Repairs in Kiln dept. B	rs./t	H	R-0.48	R-0.32
Power consumption (kiln dept.) C	kwh/t	9	8	16
Dust loss D	%	1	8	10
Running costs outside kiln dept. E	Rs./t	H	H+1.72	H+1.72
Wages F		W	W	W+0.17
Savings in running costs (wet-process plant used as basis)				
Heat consumption	A rs./t	0	2.00	2.33
Repairs in kiln dept.	B ”	0	0.48	0.32
Power cons. (kiln dept.)	C ”	0	0.04	-0.28
Dust loss	D ”	0	-0.25	-0.32
Run. costs outs. kiln dept.	E ”	0	-1.72	-1.72
Wages	F ”	0	0	0.17
Total saving in running costs Rs./t		0	0.55	0.16
Total saving in running cost Lakh Rs./yr.		0	0.9	0.3
Total increase in standing + costs		0	3.9	3.9
Total increase in running + standing costs		0	3.0	3.6

PART VI:

CONCLUSION AND RECOMMENDATION:

It has been noticed that the general attitude of the government, the cement industry, and the public has been to consider the cement demand as a constant quantity which varies only from time to time. Under this attitude, all concerned are generally caught unaware and hence unprepared by the supposedly sudden upsurge of the demand for cement. It is believed by the authors of this project study that this is not the real situation in the cement industry in particular and the economy of the country in general. The authors would like to submit that the sudden steep rise of the cement demand from the end of the second world war to the present has been due to the following factors:

1. The necessary reconstruction to replace the structures destroyed by the war.

2. The building of new structures in connection with the necessarily rapid general industrial growth of the country in order to cope with its new life as a politically independent nation.

3. The shift from lumber to concrete construction of commercial buildings and homes due to the increase in prices of lumber.

4. The government's new policy of concretizing as many main highways as possible in order to save in the maintenance of roads. The government is finally convinced that the concrete road is the cheapest road.

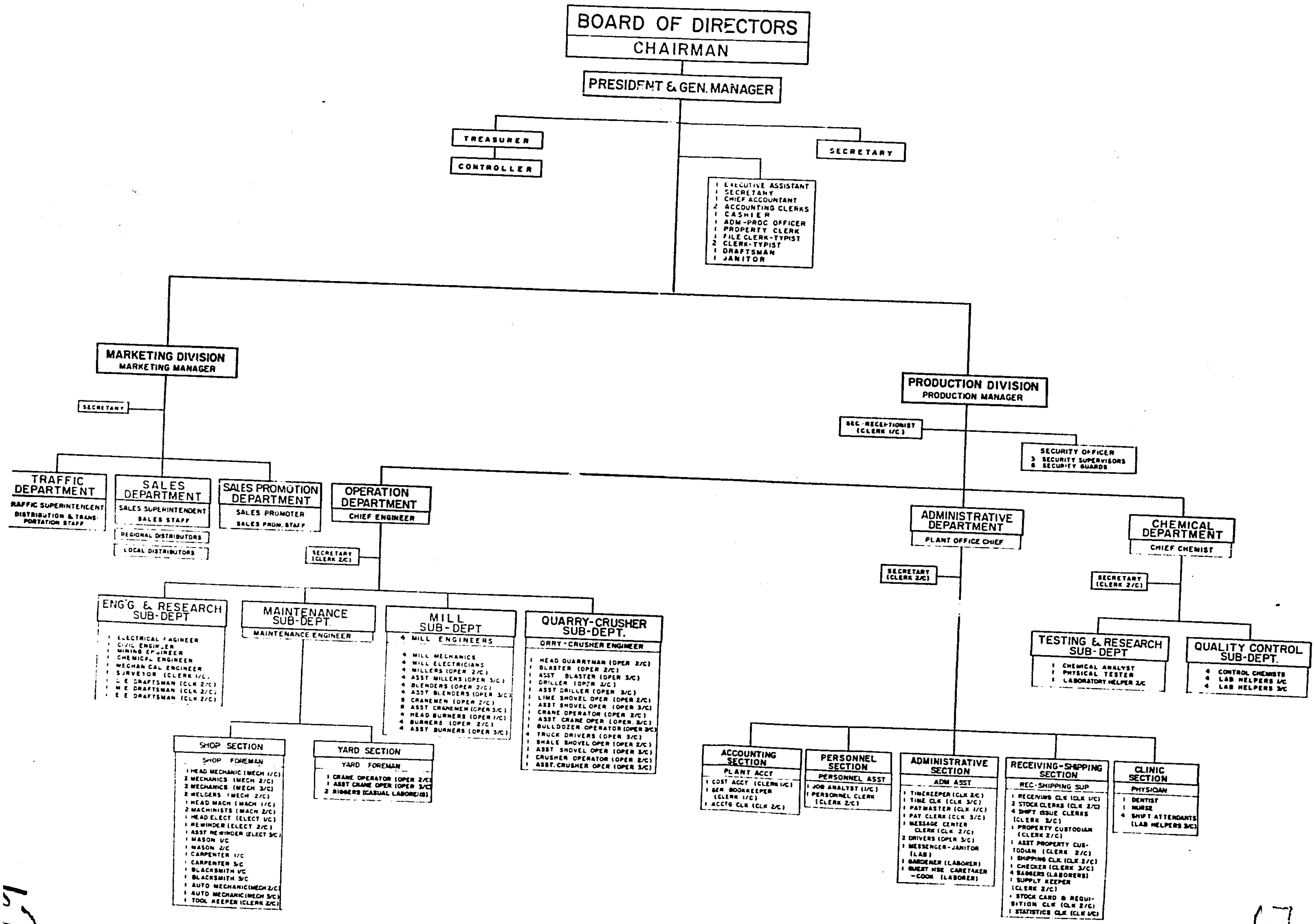
With all these factors working together it is not surprising that the increase in demand from the end of the second world war to the present has been so steep that the capital formation of the country has not been able to catch up with the demand for the products. The problem, therefore, is not only how many million bags of cement are required to satisfy the present demand but also how many million bags more are required every year henceforth. The problem is not just a matter of putting up so many cement plants now to satisfy the present demand. It is also a matter of putting up so many plants every year to take care of the fast growth in cement demand. Overproduction need not be feared as the neighboring countries of the Philippines are facing the same problem of cement shortage in even much bigger scales than does the Philippines.

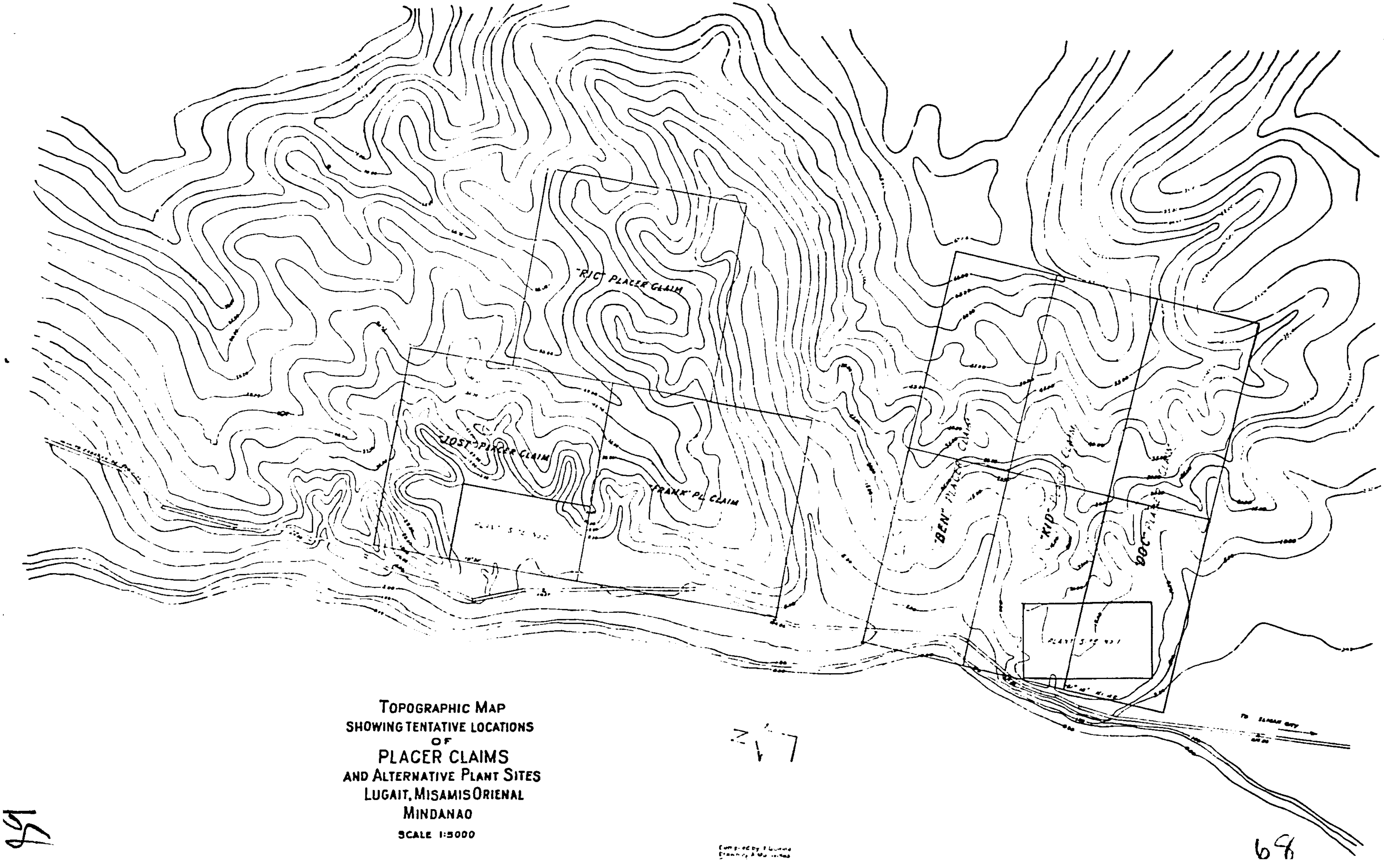
This survey team, therefore, does not only recommend the erection of the present project plant but also the erection of more cement plants after this one, such that an approximate increase of at least 5,000,000 bags a year in the market is accomplished until exportation of some of the products becomes necessary. It is believed that this company, in co-operation with local and foreign financiers, should set up a program of cement plant erection throughout the Philippines in order to meet the foregoing main problem for which this company and this team was organized.

ERRATA

1. On page 10, the phrase "(b) Preliminary Geological Survey" at the end of the third paragraph should have been the sub-title of the following paragraph.
2. On pages 12-14, and 43-44, all small o's used as exponents in the chemical formulae should have been capital O's. Examples: Ca^{o} should be CaO
   $Al_2{}^{o}{}_3$ should be Al_2O_3
3. On page 22, Section 6, Kiln Section, the working schedule should be 24 hours/day x 7 days/week, instead of 24 hours/day x 7 hours/week.

ORGANIZATION CHART OF PROPOSED CEMENT PLANT

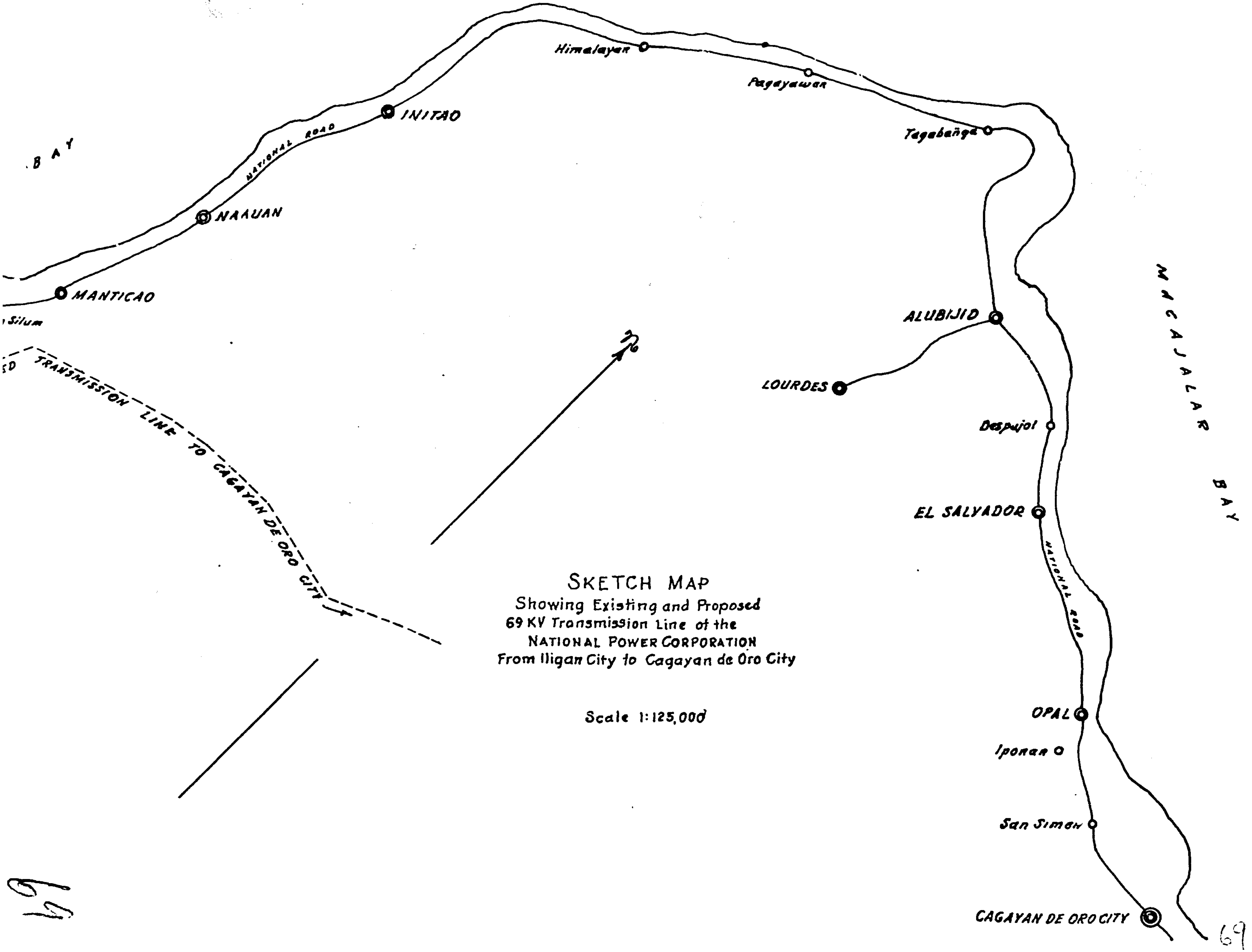




TOPOGRAPHIC MAP
SHOWING TENTATIVE LOCATIONS
OF
PLACER CLAIMS
AND ALTERNATIVE PLANT SITES
LUGAIT, MISAMIS ORIENAL
MINDANAO

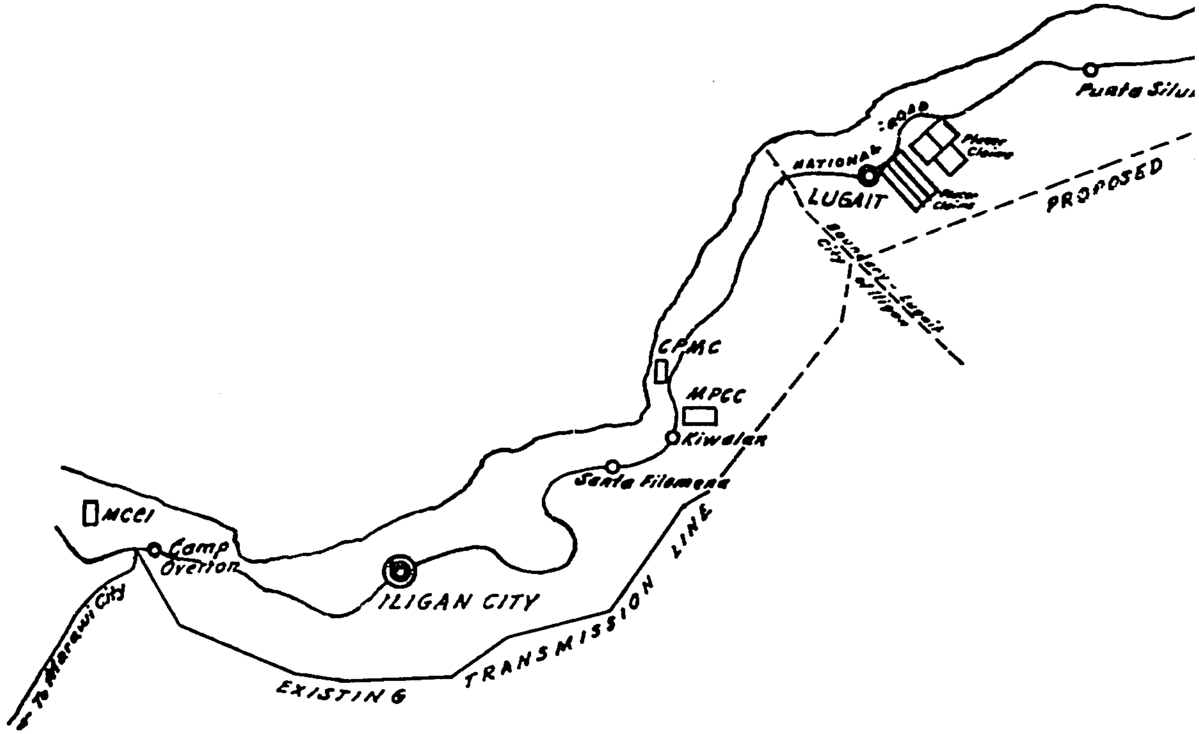
SCALE 1:5000

217



SKETCH MAP
Showing Existing and Proposed
69 KV Transmission Line of the
NATIONAL POWER CORPORATION
From Iligan City to Cagayan de Oro City

Scale 1:125,000


Punta Silu
NATIONAL ROAD
Placer Claims
Placer Claims
LUGAIT
PROPOSED
Boundary - Lugait City of Iligan
CPMC
MPCC
Kiwalan
Santa Filomena
MCCI
Camp Overton
ILIGAN CITY
To Marawi City
EXISTING TRANSMISSION LINE